Red Hat AMQ 2020.Q4

Using AMQ Streams on RHEL

For use with AMQ Streams 1.6 on Red Hat Enterprise Linux

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Legal Notice

Abstract

This guide describes how to install, configure, and manage Red Hat AMQ Streams to build a large-scale messaging network.

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CHAPTER 1. OVERVIEW OF AMQ STREAMS

Red Hat AMQ Streams is a massively-scalable, distributed, and high-performance data streaming platform based on the Apache ZooKeeper and Apache Kafka projects.

The main components comprise:

Kafka Broker

Messaging broker responsible for delivering records from producing clients to consuming clients. Apache ZooKeeper is a core dependency for Kafka, providing a cluster coordination service for highly reliable distributed coordination.

Kafka Streams API

API for writing *stream processor* applications.

Producer and Consumer APIs

Java-based APIs for producing and consuming messages to and from Kafka brokers.

Kafka Bridge

AMQ Streams Kafka Bridge provides a RESTful interface that allows HTTP-based clients to interact with a Kafka cluster.

Kafka Connect

A toolkit for streaming data between Kafka brokers and other systems using *Connector* plugins.

Kafka MirrorMaker

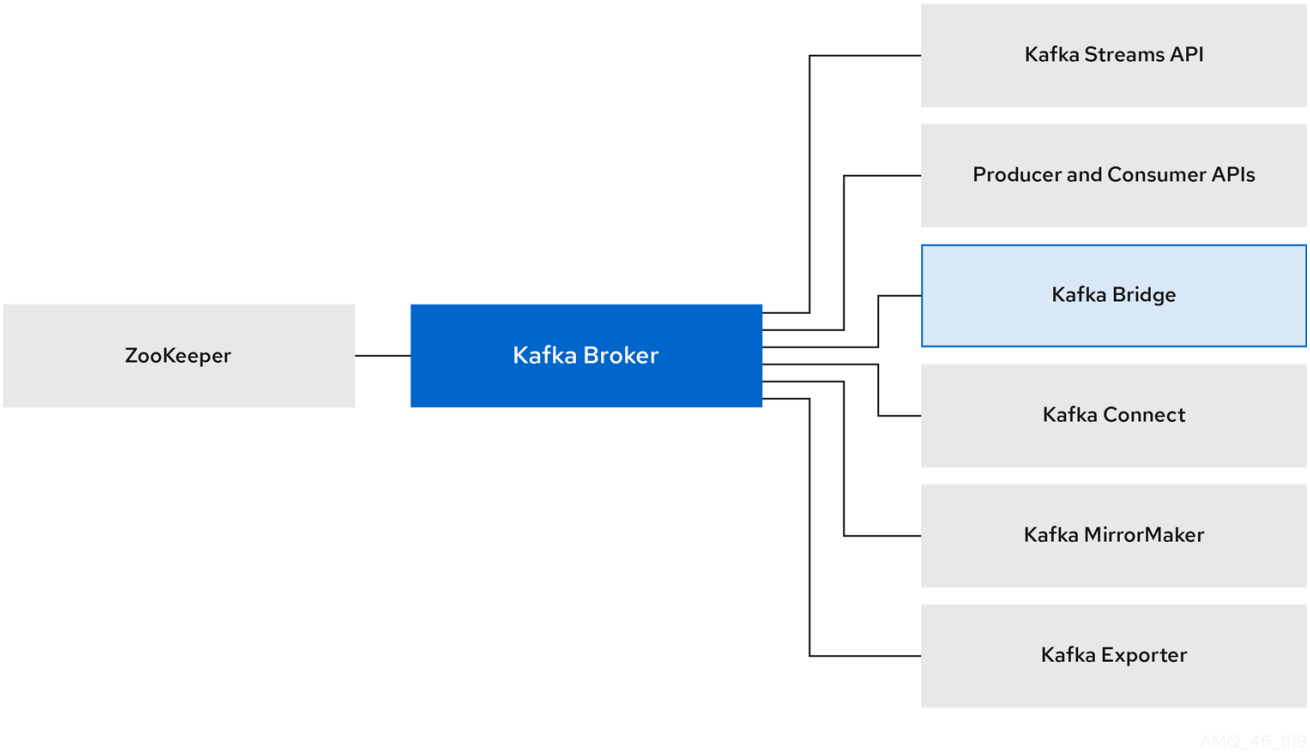
Replicates data between two Kafka clusters, within or across data centers.

Kafka Exporter

An exporter used in the extraction of Kafka metrics data for monitoring.

A cluster of Kafka brokers is the hub connecting all these components. The broker uses Apache ZooKeeper for storing configuration data and for cluster coordination. Before running Apache Kafka, an Apache ZooKeeper cluster has to be ready.

Figure 1.1. AMQ Streams architecture



1.1. KAFKA CAPABILITIES

The underlying data stream-processing capabilities and component architecture of Kafka can deliver:

- Microservices and other applications to share data with extremely high throughput and low latency
- Message ordering guarantees
- Message rewind/replay from data storage to reconstruct an application state
- Message compaction to remove old records when using a key-value log
- Horizontal scalability in a cluster configuration
- Replication of data to control fault tolerance
- Retention of high volumes of data for immediate access

1.2. KAFKA USE CASES

Kafka's capabilities make it suitable for:

- Event-driven architectures
- Event sourcing to capture changes to the state of an application as a log of events
- Message brokering
- Website activity tracking

- Operational monitoring through metrics
- Log collection and aggregation
- Commit logs for distributed systems
- Stream processing so that applications can respond to data in real time

1.3. SUPPORTED CONFIGURATIONS

In order to be running in a supported configuration, AMQ Streams must be running in one of the following JVM versions and on one of the supported operating systems.

Table 1.1. List of supported Java Virtual Machines

Java Virtual Machine	Version
OpenJDK	1.8, 11
OracleJDK	1.8
IBM JDK	1.8

Table 1.2. List of supported Operating Systems

Operating System	Architecture	Version
Red Hat Enterprise Linux	x86_64	7.x, 8.x

1.4. DOCUMENT CONVENTIONS

Replaceables

In this document, replaceable text is styled in **monospace**, with italics, uppercase, and hyphens.

For example, in the following code, you will want to replace ***BOOTSTRAP-ADDRESS*** and ***TOPIC-NAME*** with your own address and topic name:

```
bin/kafka-console-consumer.sh --bootstrap-server BOOTSTRAP-ADDRESS --topic TOPIC-NAME --from-beginning
```

CHAPTER 2. GETTING STARTED

2.1. AMQ STREAMS DISTRIBUTION

AMQ Streams is distributed as single ZIP file. This ZIP file contains AMQ Streams components:

- Apache ZooKeeper
- Apache Kafka
- Apache Kafka Connect
- Apache Kafka MirrorMaker
- Kafka Bridge
- Kafka Exporter

2.2. DOWNLOADING AN AMQ STREAMS ARCHIVE

An archived distribution of AMQ Streams is available for download from the Red Hat website. You can download a copy of the distribution by following the steps below.

Procedure

- Download the latest version of the Red Hat AMQ Streams archive from the Customer Portal.

2.3. INSTALLING AMQ STREAMS

Follow this procedure to install the latest version of AMQ Streams on Red Hat Enterprise Linux.

For instructions on upgrading an existing cluster to AMQ Streams 1.6, see AMQ Streams and Kafka upgrades.

Prerequisites

- Download the installation archive.
- Review the Section 1.3, “Supported Configurations”

Procedure

1. Add new **kafka** user and group.

```
sudo groupadd kafka
sudo useradd -g kafka kafka
sudo passwd kafka
```

2. Create directory **/opt/kafka**.

```
sudo mkdir /opt/kafka
```

3. Create a temporary directory and extract the contents of the AMQ Streams ZIP file.

```
mkdir /tmp/kafka
unzip amq-streams_y.y-x.x.x.zip -d /tmp/kafka
```

4. Move the extracted contents into **/opt/kafka** directory and delete the temporary directory.

```
sudo mv /tmp/kafka/kafka_y.y-x.x.x/* /opt/kafka/
rm -r /tmp/kafka
```

5. Change the ownership of the **/opt/kafka** directory to the **kafka** user.

```
sudo chown -R kafka:kafka /opt/kafka
```

6. Create directory **/var/lib/zookeeper** for storing ZooKeeper data and set its ownership to the **kafka** user.

```
sudo mkdir /var/lib/zookeeper
sudo chown -R kafka:kafka /var/lib/zookeeper
```

7. Create directory **/var/lib/kafka** for storing Kafka data and set its ownership to the **kafka** user.

```
sudo mkdir /var/lib/kafka
sudo chown -R kafka:kafka /var/lib/kafka
```

2.4. DATA STORAGE CONSIDERATIONS

An efficient data storage infrastructure is essential to the optimal performance of AMQ Streams.

AMQ Streams requires block storage and works well with cloud-based block storage solutions, such as Amazon Elastic Block Store (EBS). The use of file storage is not recommended.

Choose local storage when possible. If local storage is not available, you can use a Storage Area Network (SAN) accessed by a protocol such as Fibre Channel or iSCSI.

2.4.1. Apache Kafka and ZooKeeper storage support

Use separate disks for Apache Kafka and ZooKeeper.

Kafka supports JBOD (Just a Bunch of Disks) storage, a data storage configuration of multiple disks or volumes. JBOD provides increased data storage for Kafka brokers. It can also improve performance.

Solid-state drives (SSDs), though not essential, can improve the performance of Kafka in large clusters where data is sent to and received from multiple topics asynchronously. SSDs are particularly effective with ZooKeeper, which requires fast, low latency data access.

NOTE

You do not need to provision replicated storage because Kafka and ZooKeeper both have built-in data replication.

2.4.2. File systems

It is recommended that you configure your storage system to use the XFS file system. AMQ Streams is also compatible with the ext4 file system, but this might require additional configuration for best results.

Additional resources

- For more information about XFS, see The XFS File System .

2.5. RUNNING A SINGLE NODE AMQ STREAMS CLUSTER

This procedure shows how to run a basic AMQ Streams cluster consisting of a single Apache ZooKeeper node and a single Apache Kafka node, both running on the same host. The default configuration files are used for ZooKeeper and Kafka.

WARNING

A single node AMQ Streams cluster does not provide reliability and high availability and is suitable only for development purposes.

Prerequisites

- AMQ Streams is installed on the host

Running the cluster

1. Edit the ZooKeeper configuration file **/opt/kafka/config/zookeeper.properties**. Set the **dataDir** option to **/var/lib/zookeeper/**:

```
dataDir=/var/lib/zookeeper/
```

2. Edit the Kafka configuration file **/opt/kafka/config/server.properties**. Set the **log.dirs** option to **/var/lib/kafka/**:

```
log.dirs=/var/lib/kafka/
```

3. Switch to the **kafka** user:

```
su - kafka
```

4. Start ZooKeeper:

```
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

5. Check that ZooKeeper is running:

```
jcmd | grep zookeeper
```

Returns:

```
number org.apache.zookeeper.server.quorum.QuorumPeerMain
/opt/kafka/config/zookeeper.properties
```

6. Start Kafka:

```
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

7. Check that Kafka is running:

```
jcmd | grep kafka
```

Returns:

```
number kafka.Kafka /opt/kafka/config/server.properties
```

Additional resources

- For more information about installing AMQ Streams, see Section 2.3, “Installing AMQ Streams”.
- For more information about configuring AMQ Streams, see Section 2.8, “Configuring AMQ Streams”.

2.6. USING THE CLUSTER

This procedure describes how to start the Kafka console producer and consumer clients and use them to send and receive several messages.

A new topic is automatically created in step one. Topic auto-creation is controlled using the **auto.create.topics.enable** configuration property (set to **true** by default). Alternatively, you can configure and create topics before using the cluster. For more information, see Topics.

Prerequisites

- AMQ Streams is installed on the host
- ZooKeeper and Kafka are running

Procedure

1. Start the Kafka console producer and configure it to send messages to a new topic:

```
/opt/kafka/bin/kafka-console-producer.sh --broker-list <bootstrap-address> --topic <topic-name>
```

For example:

```
/opt/kafka/bin/kafka-console-producer.sh --broker-list localhost:9092 --topic my-topic
```

2. Enter several messages into the console. Press **Enter** to send each individual message to your new topic:

```
>message 1
```

```
>message 2
>message 3
>message 4
```

When Kafka creates a new topic automatically, you might receive a warning that the topic does not exist:

```
WARN Error while fetching metadata with correlation id 39 :
{4-3-16-topic1=LEADER_NOT_AVAILABLE} (org.apache.kafka.clients.NetworkClient)
```

The warning should not reappear after you send further messages.

3. In a new terminal window, start the Kafka console consumer and configure it to read messages from the beginning of your new topic.

```
/opt/kafka/bin/kafka-console-consumer.sh --bootstrap-server <bootstrap-address> --topic
<topic-name> --from-beginning
```

For example:

```
/opt/kafka/bin/kafka-console-consumer.sh --bootstrap-server localhost:9092 --topic my-topic -
-from-beginning
```

The incoming messages display in the consumer console.

4. Switch to the producer console and send additional messages. Check that they display in the consumer console.

5. Stop the Kafka console producer and then the consumer by pressing **Ctrl+C**.

2.7. STOPPING THE AMQ STREAMS SERVICES

You can stop the Kafka and ZooKeeper services by running a script. All connections to the Kafka and ZooKeeper services will be terminated.

Prerequisites

- AMQ Streams is installed on the host
- ZooKeeper and Kafka are up and running

Procedure

1. Stop the Kafka broker.

```
su - kafka
/opt/kafka/bin/kafka-server-stop.sh
```

2. Confirm that the Kafka broker is stopped.

```
jcmd | grep kafka
```

3. Stop ZooKeeper.

```
su - kafka
/opt/kafka/bin/zookeeper-server-stop.sh
```

2.8. CONFIGURING AMQ STREAMS

Prerequisites

- AMQ Streams is downloaded and installed on the host

Procedure

1. Open ZooKeeper and Kafka broker configuration files in a text editor. The configuration files are located at :

   ZooKeeper

   /opt/kafka/config/zookeeper.properties

   Kafka

   /opt/kafka/config/server.properties

2. Edit the configuration options. The configuration files are in the Java properties format. Every configuration option should be on separate line in the following format:

   ```
   <option> = <value>
   ```

   Lines starting with **#** or **!** will be treated as comments and will be ignored by AMQ Streams components.

   ```
   # This is a comment
   ```

   Values can be split into multiple lines by using \ directly before the newline / carriage return.

   ```
   sasl.jaas.config=org.apache.kafka.common.security.plain.PlainLoginModule required \
       username="bob" \
       password="bobs-password";
   ```

3. Save the changes

4. Restart the ZooKeeper or Kafka broker

5. Repeat this procedure on all the nodes of the cluster.

CHAPTER 3. CONFIGURING ZOOKEEPER

Kafka uses ZooKeeper to store configuration data and for cluster coordination. It is strongly recommended to run a cluster of replicated ZooKeeper instances.

3.1. BASIC CONFIGURATION

The most important ZooKeeper configuration options are:

tickTime

ZooKeeper's basic time unit in milliseconds. It is used for heartbeats and session timeouts. For example, minimum session timeout will be two ticks.

dataDir

The directory where ZooKeeper stores its transaction logs and snapshots of its in-memory database. This should be set to the **/var/lib/zookeeper/** directory that was created during installation.

clientPort

Port number where clients can connect. Defaults to **2181**.

An example ZooKeeper configuration file named **config/zookeeper.properties** is located in the AMQ Streams installation directory. It is recommended to place the **dataDir** directory on a separate disk device to minimize the latency in ZooKeeper.

ZooKeeper configuration file should be located in **/opt/kafka/config/zookeeper.properties**. A basic example of the configuration file can be found below. The configuration file has to be readable by the **kafka** user.

```
tickTime=2000
dataDir=/var/lib/zookeeper/
clientPort=2181
```

3.2. ZOOKEEPER CLUSTER CONFIGURATION

For reliable ZooKeeper service, you should deploy ZooKeeper in a cluster. Hence, for production use cases, you must run a cluster of replicated ZooKeeper instances. ZooKeeper clusters are also referred to as *ensembles*.

ZooKeeper clusters usually consist of an odd number of nodes. ZooKeeper requires that a majority of the nodes in the cluster are up and running. For example:

- In a cluster with three nodes, at least two of the nodes must be up and running. This means it can tolerate one node being down.
- In a cluster consisting of five nodes, at least three nodes must be available. This means it can tolerate two nodes being down.
- In a cluster consisting of seven nodes, at least four nodes must be available. This means it can tolerate three nodes being down.

Having more nodes in the ZooKeeper cluster delivers better resiliency and reliability of the whole cluster.

ZooKeeper can run in clusters with an even number of nodes. The additional node, however, does not increase the resiliency of the cluster. A cluster with four nodes requires at least three nodes to be available and can tolerate only one node being down. Therefore it has exactly the same resiliency as a

cluster with only three nodes.

Ideally, the different ZooKeeper nodes should be located in different data centers or network segments. Increasing the number of ZooKeeper nodes increases the workload spent on cluster synchronization. For most Kafka use cases, a ZooKeeper cluster with 3, 5 or 7 nodes should be sufficient.

WARNING

A ZooKeeper cluster with 3 nodes can tolerate only 1 unavailable node. This means that if a cluster node crashes while you are doing maintenance on another node your ZooKeeper cluster will be unavailable.

Replicated ZooKeeper configuration supports all configuration options supported by the standalone configuration. Additional options are added for the clustering configuration:

initLimit

Amount of time to allow followers to connect and sync to the cluster leader. The time is specified as a number of ticks (see the **timeTick** option for more details).

syncLimit

Amount of time for which followers can be behind the leader. The time is specified as a number of ticks (see the **timeTick** option for more details).

reconfigEnabled

Enables or disables dynamic reconfiguration. Must be enabled in order to add or remove servers to a ZooKeeper cluster.

standaloneEnabled

Enables or disables standalone mode, where ZooKeeper runs with only one server.

In addition to the options above, every configuration file should contain a list of servers which should be members of the ZooKeeper cluster. The server records should be specified in the format **server.id=hostname:port1:port2**, where:

id

The ID of the ZooKeeper cluster node.

hostname

The hostname or IP address where the node listens for connections.

port1

The port number used for intra-cluster communication.

port2

The port number used for leader election.

The following is an example configuration file of a ZooKeeper cluster with three nodes:

```
timeTick=2000
dataDir=/var/lib/zookeeper/
initLimit=5
syncLimit=2
```

```
reconfigEnabled=true
standaloneEnabled=false

server.1=172.17.0.1:2888:3888:participant;172.17.0.1:2181
server.2=172.17.0.2:2888:3888:participant;172.17.0.2:2181
server.3=172.17.0.3:2888:3888:participant;172.17.0.3:2181
```

NOTE

In ZooKeeper 3.5.7, the four letter word commands must be added to the allow list before they can be used. For more information, see the ZooKeeper documentation.

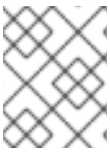
myid files

Each node in the ZooKeeper cluster must be assigned a unique **ID**. Each node's **ID** must be configured in a **myid** file and stored in the **dataDir** folder, like **/var/lib/zookeeper/**. The **myid** files should contain only a single line with the written **ID** as text. The **ID** can be any integer from 1 to 255. You must manually create this file on each cluster node. Using this file, each ZooKeeper instance will use the configuration from the corresponding **server.** line in the configuration file to configure its listeners. It will also use all other **server.** lines to identify other cluster members.

In the above example, there are three nodes, so each one will have a different **myid** with values **1**, **2**, and **3** respectively.

3.3. RUNNING MULTI-NODE ZOOKEEPER CLUSTER

This procedure will show you how to configure and run ZooKeeper as a multi-node cluster.



NOTE

In ZooKeeper 3.5.7, the four letter word commands must be added to the allow list before they can be used. For more information, see the ZooKeeper documentation.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as ZooKeeper cluster nodes.

Running the cluster

1. Create the **myid** file in **/var/lib/zookeeper/**. Enter ID **1** for the first ZooKeeper node, **2** for the second ZooKeeper node, and so on.

   ```
   su - kafka
   echo "<NodeID>" > /var/lib/zookeeper/myid
   ```

   For example:

   ```
   su - kafka
   echo "1" > /var/lib/zookeeper/myid
   ```

2. Edit the ZooKeeper **/opt/kafka/config/zookeeper.properties** configuration file for the following:

- Set the option **dataDir** to **/var/lib/zookeeper/**.
- Configure the **initLimit** and **syncLimit** options.
- Configure the **reconfigEnabled** and **standaloneEnabled** options.
- Add a list of all ZooKeeper nodes. The list should include also the current node.

Example configuration for a node of ZooKeeper cluster with five members

```
timeTick=2000
dataDir=/var/lib/zookeeper/
initLimit=5
syncLimit=2
reconfigEnabled=true
standaloneEnabled=false

server.1=172.17.0.1:2888:3888:participant;172.17.0.1:2181
server.2=172.17.0.2:2888:3888:participant;172.17.0.2:2181
server.3=172.17.0.3:2888:3888:participant;172.17.0.3:2181
server.4=172.17.0.4:2888:3888:participant;172.17.0.4:2181
server.5=172.17.0.5:2888:3888:participant;172.17.0.5:2181
```

3. Start ZooKeeper with the default configuration file.

```
su - kafka
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

4. Verify that ZooKeeper is running.

```
jcmd | grep zookeeper
```

5. Repeat this procedure on all the nodes of the cluster.
6. Once all nodes of the clusters are up and running, verify that all nodes are members of the cluster by sending a **stat** command to each of the nodes using **ncat** utility.

Use ncat stat to check the node status

```
echo stat | ncat localhost 2181
```

In the output you should see information that the node is either **leader** or **follower**.

Example output from the ncat command

```
ZooKeeper version: 3.4.13-2d71af4dbe22557fda74f9a9b4309b15a7487f03, built on
06/29/2018 00:39 GMT
Clients:
 /0:0:0:0:0:0:0:1:59726[0](queued=0,recved=1,sent=0)

Latency min/avg/max: 0/0/0
Received: 2
Sent: 1
Connections: 1
```

```
Outstanding: 0
Zxid: 0x200000000
Mode: follower
Node count: 4
```

Additional resources

- For more information about installing AMQ Streams, see Section 2.3, "Installing AMQ Streams".
- For more information about configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".

3.4. AUTHENTICATION

By default, ZooKeeper does not use any form of authentication and allows anonymous connections. However, it supports Java Authentication and Authorization Service (JAAS) which can be used to set up authentication using Simple Authentication and Security Layer (SASL). ZooKeeper supports authentication using the DIGEST-MD5 SASL mechanism with locally stored credentials.

3.4.1. Authentication with SASL

JAAS is configured using a separate configuration file. It is recommended to place the JAAS configuration file in the same directory as the ZooKeeper configuration (/**opt**/**kafka**/**config**/). The recommended file name is **zookeeper-jaas.conf**. When using a ZooKeeper cluster with multiple nodes, the JAAS configuration file has to be created on all cluster nodes.

JAAS is configured using contexts. Separate parts such as the server and client are always configured with a separate *context*. The context is a *configuration* option and has the following format:

```
ContextName {
    param1
    param2;
};
```

SASL Authentication is configured separately for server-to-server communication (communication between ZooKeeper instances) and client-to-server communication (communication between Kafka and ZooKeeper). Server-to-server authentication is relevant only for ZooKeeper clusters with multiple nodes.

Server-to-Server authentication

For server-to-server authentication, the JAAS configuration file contains two parts:

- The server configuration
- The client configuration

When using DIGEST-MD5 SASL mechanism, the **QuorumServer** context is used to configure the authentication server. It must contain all the usernames to be allowed to connect together with their passwords in an unencrypted form. The second context, **QuorumLearner**, has to be configured for the client which is built into ZooKeeper. It also contains the password in an unencrypted form. An example of the JAAS configuration file for DIGEST-MD5 mechanism can be found below:

```
QuorumServer {
    org.apache.zookeeper.server.auth.DigestLoginModule required
```

```
        user_zookeeper="123456";
};

QuorumLearner {
        org.apache.zookeeper.server.auth.DigestLoginModule required
        username="zookeeper"
        password="123456";
};
```

In addition to the JAAS configuration file, you must enable the server-to-server authentication in the regular ZooKeeper configuration file by specifying the following options:

```
quorum.auth.enableSasl=true
quorum.auth.learnerRequireSasl=true
quorum.auth.serverRequireSasl=true
quorum.auth.learner.loginContext=QuorumLearner
quorum.auth.server.loginContext=QuorumServer
quorum.cnxn.threads.size=20
```

Use the **KAFKA_OPTS** environment variable to pass the JAAS configuration file to the ZooKeeper server as a Java property:

```
su - kafka
export KAFKA_OPTS="-Djava.security.auth.login.config=/opt/kafka/config/zookeeper-jaas.conf";
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

For more information about server-to-server authentication, see ZooKeeper wiki.

Client-to-Server authentication

Client-to-server authentication is configured in the same JAAS file as the server-to-server authentication. However, unlike the server-to-server authentication, it contains only the server configuration. The client part of the configuration has to be done in the client. For information on how to configure a Kafka broker to connect to ZooKeeper using authentication, see the Kafka installation section.

Add the Server context to the JAAS configuration file to configure client-to-server authentication. For DIGEST-MD5 mechanism it configures all usernames and passwords:

```
Server {
   org.apache.zookeeper.server.auth.DigestLoginModule required
   user_super="123456"
   user_kafka="123456"
   user_someoneelse="123456";
};
```

After configuring the JAAS context, enable the client-to-server authentication in the ZooKeeper configuration file by adding the following line:

```
requireClientAuthScheme=sasl
authProvider.1=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
authProvider.2=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
authProvider.3=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
```

You must add the **authProvider.*<ID>*** property for every server that is part of the ZooKeeper cluster.

Use the **KAFKA_OPTS** environment variable to pass the JAAS configuration file to the ZooKeeper server as a Java property:

```
su - kafka
export KAFKA_OPTS="-Djava.security.auth.login.config=/opt/kafka/config/zookeeper-jaas.conf";
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

For more information about configuring ZooKeeper authentication in Kafka brokers, see Section 4.6, “ZooKeeper authentication”.

3.4.2. Enabling Server-to-server authentication using DIGEST-MD5

This procedure describes how to enable authentication using the SASL DIGEST-MD5 mechanism between the nodes of the ZooKeeper cluster.

Prerequisites

- AMQ Streams is installed on the host
- ZooKeeper cluster is configured with multiple nodes.

Enabling SASL DIGEST-MD5 authentication

1. On all ZooKeeper nodes, create or edit the **/opt/kafka/config/zookeeper-jaas.conf** JAAS configuration file and add the following contexts:

```
QuorumServer {
    org.apache.zookeeper.server.auth.DigestLoginModule required
    user_<Username>="<Password>";
};

QuorumLearner {
    org.apache.zookeeper.server.auth.DigestLoginModule required
    username="<Username>"
    password="<Password>";
};
```

   The username and password must be the same in both JAAS contexts. For example:

```
QuorumServer {
    org.apache.zookeeper.server.auth.DigestLoginModule required
    user_zookeeper="123456";
};

QuorumLearner {
    org.apache.zookeeper.server.auth.DigestLoginModule required
    username="zookeeper"
    password="123456";
};
```

2. On all ZooKeeper nodes, edit the **/opt/kafka/config/zookeeper.properties** ZooKeeper configuration file and set the following options:

```
quorum.auth.enableSasl=true
```

```
quorum.auth.learnerRequireSasl=true
quorum.auth.serverRequireSasl=true
quorum.auth.learner.loginContext=QuorumLearner
quorum.auth.server.loginContext=QuorumServer
quorum.cnxn.threads.size=20
```

3. Restart all ZooKeeper nodes one by one. To pass the JAAS configuration to ZooKeeper, use the **KAFKA_OPTS** environment variable.

```
su - kafka
export KAFKA_OPTS="-Djava.security.auth.login.config=/opt/kafka/config/zookeeper-jaas.conf"; /opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

Additional resources

- For more information about installing AMQ Streams, see Section 2.3, “Installing AMQ Streams”.
- For more information about configuring AMQ Streams, see Section 2.8, “Configuring AMQ Streams”.
- For more information about running a ZooKeeper cluster, see Section 3.3, “Running multi-node ZooKeeper cluster”.

3.4.3. Enabling Client-to-server authentication using DIGEST-MD5

This procedure describes how to enable authentication using the SASL DIGEST-MD5 mechanism between ZooKeeper clients and ZooKeeper.

Prerequisites

- AMQ Streams is installed on the host
- ZooKeeper cluster is configured and running.

Enabling SASL DIGEST-MD5 authentication

1. On all ZooKeeper nodes, create or edit the **/opt/kafka/config/zookeeper-jaas.conf** JAAS configuration file and add the following context:

```
Server {
   org.apache.zookeeper.server.auth.DigestLoginModule required
   user_super="<SuperUserPassword>"
   user<Username1>_="<Password1>" user<USername2>_="<Password2>";
};
```

   The **super** automatically has administrator priviledges. The file can contain multiple users, but only one additional user is required by the Kafka brokers. The recommended name for the Kafka user is **kafka**.

   The following example shows the **Server** context for client-to-server authentication:

```
Server {
   org.apache.zookeeper.server.auth.DigestLoginModule required
```

```
    user_super="123456"
    user_kafka="123456";
};
```

2. On all ZooKeeper nodes, edit the **/opt/kafka/config/zookeeper.properties** ZooKeeper configuration file and set the following options:

```
requireClientAuthScheme=sasl
authProvider.<IdOfBroker1>=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
authProvider.<IdOfBroker2>=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
authProvider.<IdOfBroker3>=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
```

The **authProvider.*<ID>*** property has to be added for every node which is part of the ZooKeeper cluster. An example three-node ZooKeeper cluster configuration must look like the following:

```
requireClientAuthScheme=sasl
authProvider.1=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
authProvider.2=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
authProvider.3=org.apache.zookeeper.server.auth.SASLAuthenticationProvider
```

3. Restart all ZooKeeper nodes one by one. To pass the JAAS configuration to ZooKeeper, use the **KAFKA_OPTS** environment variable.

```
su - kafka
export KAFKA_OPTS="-Djava.security.auth.login.config=/opt/kafka/config/zookeeper-
jaas.conf"; /opt/kafka/bin/zookeeper-server-start.sh -daemon
/opt/kafka/config/zookeeper.properties
```

Additional resources

- For more information about installing AMQ Streams, see Section 2.3, “Installing AMQ Streams”.
- For more information about configuring AMQ Streams, see Section 2.8, “Configuring AMQ Streams”.
- For more information about running a ZooKeeper cluster, see Section 3.3, “Running multi-node ZooKeeper cluster”.

3.5. AUTHORIZATION

ZooKeeper supports access control lists (ACLs) to protect data stored inside it. Kafka brokers can automatically configure the ACL rights for all ZooKeeper records they create so no other ZooKeeper user can modify them.

For more information about enabling ZooKeeper ACLs in Kafka brokers, see Section 4.8, “ZooKeeper authorization”.

3.6. TLS

ZooKeeper supports TLS for encryption or authentication.

3.7. ADDITIONAL CONFIGURATION OPTIONS

You can set the following additional ZooKeeper configuration options based on your use case:

maxClientCnxns

The maximum number of concurrent client connections to a single member of the ZooKeeper cluster.

autopurge.snapRetainCount

Number of snapshots of ZooKeeper's in-memory database which will be retained. Default value is **3**.

autopurge.purgeInterval

The time interval in hours for purging snapshots. The default value is **0** and this option is disabled.

All available configuration options can be found in the ZooKeeper documentation.

3.8. LOGGING

ZooKeeper is using *log4j* as their logging infrastructure. Logging configuration is by default read from the **log4j.properties** configuration file which should be placed either in the **/opt/kafka/config/** directory or in the classpath. The location and name of the configuration file can be changed using the Java property **log4j.configuration** which can be passed to ZooKeeper using the **KAFKA_LOG4J_OPTS** environment variable:

```
su - kafka
export KAFKA_LOG4J_OPTS="-Dlog4j.configuration=file:/my/path/to/log4j.properties";
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

For more information about Log4j configurations, see Log4j documentation.

CHAPTER 4. CONFIGURING KAFKA

Kafka uses a properties file to store static configuration. The recommended location for the configuration file is **/opt/kafka/config/server.properties**. The configuration file has to be readable by the **kafka** user.

AMQ Streams ships an example configuration file that highlights various basic and advanced features of the product. It can be found under **config/server.properties** in the AMQ Streams installation directory.

This chapter explains the most important configuration options. For a complete list of supported Kafka broker configuration options, see Appendix A, *Broker configuration parameters*.

4.1. ZOOKEEPER

Kafka brokers need ZooKeeper to store some parts of their configuration as well as to coordinate the cluster (for example to decide which node is a leader for which partition). Connection details for the ZooKeeper cluster are stored in the configuration file. The field **zookeeper.connect** contains a comma-separated list of hostnames and ports of members of the zookeeper cluster.

For example:

```
zookeeper.connect=zoo1.my-domain.com:2181,zoo2.my-domain.com:2181,zoo3.my-domain.com:2181
```

Kafka will use these addresses to connect to the ZooKeeper cluster. With this configuration, all Kafka **znodes** will be created directly in the root of ZooKeeper database. Therefore, such a ZooKeeper cluster could be used only for a single Kafka cluster. To configure multiple Kafka clusters to use single ZooKeeper cluster, specify a base (prefix) path at the end of the ZooKeeper connection string in the Kafka configuration file:

```
zookeeper.connect=zoo1.my-domain.com:2181,zoo2.my-domain.com:2181,zoo3.my-domain.com:2181/my-cluster-1
```

4.2. LISTENERS

Kafka brokers can be configured to use multiple listeners. Each listener can be used to listen on a different port or network interface and can have different configuration. Listeners are configured in the **listeners** property in the configuration file. The **listeners** property contains a list of listeners with each listener configured as ***<listenerName>***://***<hostname>***:_<**port**>_. When the hostname value is empty, Kafka will use **java.net.InetAddress.getCanonicalHostName()** as hostname. The following example shows how multiple listeners might be configured:

```
listeners=INT1://:9092,INT2://:9093,REPLICATION://:9094
```

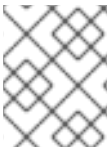
When a Kafka client wants to connect to a Kafka cluster, it first connects to a *bootstrap server*. The *bootstrap server* is one of the cluster nodes. It will provide the client with a list of all other brokers which are part of the cluster and the client will connect to them individually. By default the *bootstrap server* will provide the client with a list of nodes based on the **listeners** field.

Advertised listeners

It is possible to give the client a different set of addresses than given in the listeners property. It is useful in situations when additional network infrastructure, such as a proxy, is between the client and the broker, or when an external DNS name should be used instead of an IP address. Here, the broker allows

defining the advertised addresses of the listeners in the advertised.listeners configuration property. This property has the same format as the listeners property. The following example shows how to configure advertised listeners:

```
listeners=INT1://:9092,INT2://:9093
advertised.listeners=INT1://my-broker-1.my-domain.com:1234,INT2://my-broker-1.my-domain.com:1234:9093
```



NOTE

The names of the listeners have to match the names of the listeners from the **listeners** property.

Inter-broker listeners

When the cluster has replicated topics, the brokers responsible for such topics need to communicate with each other in order to replicate the messages in those topics. When multiple listeners are configured, the configuration field **inter.broker.listener.name** can be used to specify the name of the listener which should be used for replication between brokers. For example:

```
inter.broker.listener.name=REPLICATION
```

4.3. COMMIT LOGS

Apache Kafka stores all records it receives from producers in commit logs. The commit logs contain the actual data, in the form of records, that Kafka needs to deliver. These are not the application log files which record what the broker is doing.

Log directories

You can configure log directories using the **log.dirs** property file to store commit logs in one or multiple log directories. It should be set to **/var/lib/kafka** directory created during installation:

```
log.dirs=/var/lib/kafka
```

For performance reasons, you can configure log.dirs to multiple directories and place each of them on a different physical device to improve disk I/O performance. For example:

```
log.dirs=/var/lib/kafka1,/var/lib/kafka2,/var/lib/kafka3
```

4.4. BROKER ID

Broker ID is a unique identifier for each broker in the cluster. You can assign an integer greater than or equal to 0 as broker ID. The broker ID is used to identify the brokers after restarts or crashes and it is therefore important that the id is stable and does not change over time. The broker ID is configured in the broker properties file:

```
broker.id=1
```

4.5. RUNNING A MULTI-NODE KAFKA CLUSTER

This procedure describes how to configure and run Kafka as a multi-node cluster.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.
- A ZooKeeper cluster is configured and running.

Running the cluster

For each Kafka broker in your AMQ Streams cluster:

1. Edit the **/opt/kafka/config/server.properties** Kafka configuration file as follows:
   - Set the **broker.id** field to **0** for the first broker, **1** for the second broker, and so on.
   - Configure the details for connecting to ZooKeeper in the **zookeeper.connect** option.
   - Configure the Kafka listeners.
   - Set the directories where the commit logs should be stored in the **logs.dir** directory.

   Here we see an example configuration for a Kafka broker:

   ```
   broker.id=0
   zookeeper.connect=zoo1.my-domain.com:2181,zoo2.my-domain.com:2181,zoo3.my-domain.com:2181
   listeners=REPLICATION://:9091,PLAINTEXT://:9092
   inter.broker.listener.name=REPLICATION
   log.dirs=/var/lib/kafka
   ```

   In a typical installation where each Kafka broker is running on identical hardware, only the **broker.id** configuration property will differ between each broker config.
2. Start the Kafka broker with the default configuration file.

   ```
   su - kafka
   /opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
   ```
3. Verify that the Kafka broker is running.

   ```
   jcmd | grep Kafka
   ```

Verifying the brokers

Once all nodes of the clusters are up and running, verify that all nodes are members of the Kafka cluster by sending a **dump** command to one of the ZooKeeper nodes using the **ncat** utility. The command prints all Kafka brokers registered in ZooKeeper.

1. Use ncat stat to check the node status.

   ```
   echo dump | ncat zoo1.my-domain.com 2181
   ```

   The output should contain all Kafka brokers you just configured and started.

   Example output from the **ncat** command for Kafka cluster with 3 nodes:

```
SessionTracker dump:
org.apache.zookeeper.server.quorum.LearnerSessionTracker@28848ab9
ephemeral nodes dump:
Sessions with Ephemerals (3):
0x20000015dd00000:
        /brokers/ids/1
0x10000015dc70000:
        /controller
        /brokers/ids/0
0x10000015dc70001:
        /brokers/ids/2
```

Additional resources

- For more information about installing AMQ Streams, see Section 2.3, "Installing AMQ Streams".
- For more information about configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".
- For more information about running a ZooKeeper cluster, see Section 3.3, "Running multi-node ZooKeeper cluster".
- For a complete list of supported Kafka broker configuration options, see Appendix A, *Broker configuration parameters*.

4.6. ZOOKEEPER AUTHENTICATION

By default, connections between ZooKeeper and Kafka are not authenticated. However, Kafka and ZooKeeper support Java Authentication and Authorization Service (JAAS) which can be used to set up authentication using Simple Authentication and Security Layer (SASL). ZooKeeper supports authentication using the DIGEST-MD5 SASL mechanism with locally stored credentials.

4.6.1. JAAS Configuration

SASL authentication for ZooKeeper connections has to be configured in the JAAS configuration file. By default, Kafka will use the JAAS context named **Client** for connecting to ZooKeeper. The **Client** context should be configured in the **/opt/kafka/config/jass.conf** file. The context has to enable the **PLAIN** SASL authentication, as in the following example:

```
Client {
    org.apache.kafka.common.security.plain.PlainLoginModule required
    username="kafka"
    password="123456";
};
```

4.6.2. Enabling ZooKeeper authentication

This procedure describes how to enable authentication using the SASL DIGEST-MD5 mechanism when connecting to ZooKeeper.

Prerequisites

- Client-to-server authentication is enabled in ZooKeeper

Enabling SASL DIGEST-MD5 authentication

1. On all Kafka broker nodes, create or edit the **/opt/kafka/config/jaas.conf** JAAS configuration file and add the following context:

```
Client {
    org.apache.kafka.common.security.plain.PlainLoginModule required
    username="<Username>"
    password="<Password>";
};
```

   The username and password should be the same as configured in ZooKeeper.

   Following example shows the **Client** context:

```
Client {
    org.apache.kafka.common.security.plain.PlainLoginModule required
    username="kafka"
    password="123456";
};
```

2. Restart all Kafka broker nodes one by one. To pass the JAAS configuration to Kafka brokers, use the **KAFKA_OPTS** environment variable.

```
su - kafka
export KAFKA_OPTS="-Djava.security.auth.login.config=/opt/kafka/config/jaas.conf";
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

Additional resources

- For more information about configuring client-to-server authentication in ZooKeeper, see Section 3.4, “Authentication”.

4.7. AUTHORIZATION

Authorization in Kafka brokers is implemented using authorizer plugins.

In this section we describe how to use the **AclAuthorizer** plugin provided with Kafka.

Alternatively, you can use your own authorization plugins. For example, if you are using OAuth 2.0 token-based authentication, you can use OAuth 2.0 authorization.

4.7.1. Simple ACL authorizer

Authorizer plugins, including **AclAuthorizer**, are enabled through the **authorizer.class.name** property:

```
authorizer.class.name=kafka.security.auth.SimpleAclAuthorizer
```

A fully-qualified name is required for the chosen authorizer. For **AclAuthorizer**, the fully-qualified name is **kafka.security.auth.SimpleAclAuthorizer**.

4.7.1.1. ACL rules

AclAuthorizer uses ACL rules to manage access to Kafka brokers.

ACL rules are defined in the format:

Principal **P** is allowed / denied operation **O** on Kafka resource **R** from host **H**

For example, a rule might be set so that user:

John can **view** the topic **comments** from host **127.0.0.1**

Host is the IP address of the machine that John is connecting from.

In most cases, the user is a producer or consumer application:

Consumer01 can **write** to the consumer group **accounts** from host **127.0.0.1**

If ACL rules are not present

If ACL rules are not present for a given resource, all actions are denied. This behavior can be changed by setting the property **allow.everyone.if.no.acl.found** to **true** in the Kafka configuration file **/opt/kafka/config/server.properties**.

4.7.1.2. Principals

A *principal* represents the identity of a user. The format of the ID depends on the authentication mechanism used by clients to connect to Kafka:

- **User:ANONYMOUS** when connected without authentication.
- **User:<username>** when connected using simple authentication mechanisms, such as PLAIN or SCRAM.
  For example **User:admin** or **User:user1**.
- **User:<DistinguishedName>** when connected using TLS client authentication.
  For example **User:CN=user1,O=MyCompany,L=Prague,C=CZ**.
- **User:<Kerberos username>** when connected using Kerberos.

The *DistinguishedName* is the distinguished name from the client certificate.

The *Kerberos username* is the primary part of the Kerberos principal, which is used by default when connecting using Kerberos. You can use the **sasl.kerberos.principal.to.local.rules** property to configure how the Kafka principal is built from the Kerberos principal.

4.7.1.3. Authentication of users

To use authorization, you need to have authentication enabled and used by your clients. Otherwise, all connections will have the principal **User:ANONYMOUS**.

For more information on methods of authentication, see Encryption and authentication.

4.7.1.4. Super users

Super users are allowed to take all actions regardless of the ACL rules.

Super users are defined in the Kafka configuration file using the property **super.users**.

For example:

```
super.users=User:admin,User:operator
```

4.7.1.5. Replica broker authentication

When authorization is enabled, it is applied to all listeners and all connections. This includes the inter-broker connections used for replication of data between brokers. If enabling authorization, therefore, ensure that you use authentication for inter-broker connections and give the users used by the brokers sufficient rights. For example, if authentication between brokers uses the **kafka-broker** user, then super user configuration must include the username **super.users=User:kafka-broker**.

4.7.1.6. Supported resources

You can apply Kafka ACLs to these types of resource:

- Topics
- Consumer groups
- The cluster
- TransactionId
- DelegationToken

4.7.1.7. Supported operations

AclAuthorizer authorizes operations on resources.

Fields with **X** in the following table mark the supported operations for each resource.

Table 4.1. Supported operations for a resource

	Topics	Consumer Groups	Cluster
Read	X	X	
Write	X		
Create			X
Delete	X		
Alter	X		
Describe	X	X	X
ClusterAction			X
All	X	X	X

4.7.1.8. ACL management options

ACL rules are managed using the **bin/kafka-acls.sh** utility, which is provided as part of the Kafka distribution package.

Use **kafka-acls.sh** parameter options to add, list and remove ACL rules, and perform other functions.

The parameters require a double-hyphen convention, such as **--add**.

Option	Type	Description	Default
add	Action	Add ACL rule.	
remove	Action	Remove ACL rule.	
list	Action	List ACL rules.	
authorizer	Action	Fully-qualified class name of the authorizer.	**kafka.security.auth.SimpleAclAuthorizer**
authorizer-properties	Configuration	Key/value pairs passed to the authorizer for initialization. For **AclAuthorizer**, the example values are: **zookeeper.connect=zoo1.my-domain.com:2181**.	
bootstrap-server	Resource	Host/port pairs to connect to the Kafka cluster.	Use this option or the **authorizer** option, not both.
command-config	Resource	Configuration property file to pass to the Admin Client, which is used in conjunction with the **bootstrap-server** parameter.	
cluster	Resource	Specifies a cluster as an ACL resource.	

Option	Type	Description	Default
topic	Resource	Specifies a topic name as an ACL resource. An asterisk (*) used as a wildcard translates to *all topics*. A single command can specify multiple **--topic** options.	
group	Resource	Specifies a consumer group name as an ACL resource. A single command can specify multiple **--group** options.	
transactional-id	Resource	Specifies a transactional ID as an ACL resource. Transactional delivery means that all messages sent by a producer to multiple partitions must be successfully delivered or none of them. An asterisk (*) used as a wildcard translates to *all IDs*.	
delegation-token	Resource	Specifies a delegation token as an ACL resource. An asterisk (*) used as a wildcard translates to *all tokens*.	

Option	Type	Description	Default
resource-pattern-type	Configuration	Specifies a type of resource pattern for the **add** parameter or a resource pattern filter value for the **list** or **remove** parameters. Use **literal** or **prefixed** as the resource pattern type for a resource name. Use **any** or **match** as resource pattern filter values, or a specific pattern type filter.	**literal**
allow-principal	Principal	Principal added to an allow ACL rule. A single command can specify multiple **--allow-principal** options.	
deny-principal	Principal	Principal added to a deny ACL rule. A single command can specify multiple **--deny-principal** options.	
principal	Principal	Principal name used with the **list** parameter to return a list of ACLs for the principal. A single command can specify multiple **--principal** options.	
allow-host	Host	IP address that allows access to the principals listed in **--allow-principal**. Hostnames or CIDR ranges are not supported.	If **--allow-principal** is specified, defaults to * meaning "all hosts".

Option	Type	Description	Default
deny-host	Host	IP address that denies access to the principals listed in **--deny-principal**. Hostnames or CIDR ranges are not supported.	if **--deny-principal** is specified, defaults to * meaning "all hosts".
operation	Operation	Allows or denies an operation. A single command can specify multipleMultiple **--operation** options can be specified in single command.	All
producer	Shortcut	A shortcut to allow or deny all operations needed by a message producer (WRITE and DESCRIBE on topic, CREATE on cluster).	
consumer	Shortcut	A shortcut to allow or deny all operations needed by a message consumer (READ and DESCRIBE on topic, READ on consumer group).	
idempotent	Shortcut	A shortcut to enable idempotence when used with the **--producer** parameter, so that messages are delivered exactly once to a partition. Idepmotence is enabled automatically if the producer is authorized to send messages based on a specific transactional ID.	

Option	Type	Description	Default
force	Shortcut	A shortcut to accept all queries and do not prompt.	

4.7.2. Enabling authorization

This procedure describes how to enable the **AclAuthorizer** plugin for authorization in Kafka brokers.

Prerequisites

- AMQ Streams is installed on all hosts used as Kafka brokers.

Procedure

1. Edit the **/opt/kafka/config/server.properties** Kafka configuration file to use the **AclAuthorizer**.

```
authorizer.class.name=kafka.security.auth.SimpleAclAuthorizer
```

2. (Re)start the Kafka brokers.

Additional resources

- For more information about configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".
- For more information about running a Kafka cluster, see Section 4.5, "Running a multi-node Kafka cluster".

4.7.3. Adding ACL rules

AclAuthorizer uses Access Control Lists (ACLs), which define a set of rules describing what users can and cannot do.

This procedure describes how to add ACL rules when using the **AclAuthorizer** plugin in Kafka brokers.

Rules are added using the **kafka-acls.sh** utility and stored in ZooKeeper.

Prerequisites

- AMQ Streams is installed on all hosts used as Kafka brokers.
- Authorization is enabled in Kafka brokers.

Procedure

1. Run **kafka-acls.sh** with the **--add** option.
   Examples:
   - Allow **user1** and **user2** access to read from **myTopic** using the **MyConsumerGroup** consumer group.

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181
--add --operation Read --topic myTopic --allow-principal User:user1 --allow-principal
User:user2

bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181
--add --operation Describe --topic myTopic --allow-principal User:user1 --allow-principal
User:user2

bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181
--add --operation Read --operation Describe --group MyConsumerGroup --allow-
principal User:user1 --allow-principal User:user2
```

- Deny **user1** access to read **myTopic** from IP address host **127.0.0.1**.

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181
--add --operation Describe --operation Read --topic myTopic --group MyConsumerGroup
--deny-principal User:user1 --deny-host 127.0.0.1
```

- Add **user1** as the consumer of **myTopic** with **MyConsumerGroup**.

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181
--add --consumer --topic myTopic --group MyConsumerGroup --allow-principal
User:user1
```

Additional resources

- For a list of all **kafka-acls.sh** options, see Section 4.7.1, “Simple ACL authorizer”.

4.7.4. Listing ACL rules

This procedure describes how to list existing ACL rules when using the **AclAuthorizer** plugin in Kafka brokers.

Rules are listed using the **kafka-acls.sh** utility.

Prerequisites

- AMQ Streams is installed on all hosts used as Kafka brokers.
- Authorization is enabled in Kafka brokers
- ACLs have been added.

Procedure

- Run **kafka-acls.sh** with the **--list** option.
  For example:

```
$ bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181 --
list --topic myTopic

Current ACLs for resource `Topic:myTopic`:

User:user1 has Allow permission for operations: Read from hosts: *
```

```
User:user2 has Allow permission for operations: Read from hosts: *
User:user2 has Deny permission for operations: Read from hosts: 127.0.0.1
User:user1 has Allow permission for operations: Describe from hosts: *
User:user2 has Allow permission for operations: Describe from hosts: *
User:user2 has Deny permission for operations: Describe from hosts: 127.0.0.1
```

Additional resources

- For a list of all **kafka-acls.sh** options, see Section 4.7.1, "Simple ACL authorizer" .

4.7.5. Removing ACL rules

This procedure describes how to remove ACL rules when using the **AclAuthorizer** plugin in Kafka brokers.

Rules are removed using the **kafka-acls.sh** utility.

Prerequisites

- AMQ Streams is installed on all hosts used as Kafka brokers.
- Authorization is enabled in Kafka brokers.
- ACLs have been added.

Procedure

- Run **kafka-acls.sh** with the **--remove** option.
  Examples:
- Remove the ACL allowing Allow **user1** and **user2** access to read from **myTopic** using the **MyConsumerGroup** consumer group.

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181 --remove --operation Read --topic myTopic --allow-principal User:user1 --allow-principal User:user2

bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181 --remove --operation Describe --topic myTopic --allow-principal User:user1 --allow-principal User:user2

bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181 --remove --operation Read --operation Describe --group MyConsumerGroup --allow-principal User:user1 --allow-principal User:user2
```

- Remove the ACL adding **user1** as the consumer of **myTopic** with **MyConsumerGroup**.

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181 --remove --consumer --topic myTopic --group MyConsumerGroup --allow-principal User:user1
```

- Remove the ACL denying **user1** access to read **myTopic** from IP address host **127.0.0.1**.

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=zoo1.my-domain.com:2181 --remove --operation Describe --operation Read --topic myTopic --group MyConsumerGroup --deny-principal User:user1 --deny-host 127.0.0.1
```

Additional resources

- For a list of all **kafka-acls.sh** options, see Section 4.7.1, "Simple ACL authorizer" .
- For more information about enabling authorization, see Section 4.7.2, "Enabling authorization".

4.8. ZOOKEEPER AUTHORIZATION

When authentication is enabled between Kafka and ZooKeeper, you can use ZooKeeper Access Control List (ACL) rules to automatically control access to Kafka's metadata stored in ZooKeeper.

4.8.1. ACL Configuration

Enforcement of ZooKeeper ACL rules is controlled by the **zookeeper.set.acl** property in the **config/server.properties** Kafka configuration file.

The property is disabled by default and enabled by setting to **true**:

```
zookeeper.set.acl=true
```

If ACL rules are enabled, when a **znode** is created in ZooKeeper only the Kafka user who created it can modify or delete it. All other users have read-only access.

Kafka sets ACL rules only for newly created ZooKeeper **znodes**. If the ACLs are only enabled after the first start of the cluster, the **zookeeper-security-migration.sh** tool can set ACLs on all existing **znodes**.

Confidentiality of data in ZooKeeper

Data stored in ZooKeeper includes:

- Topic names and their configuration
- Salted and hashed user credentials when SASL SCRAM authentication is used.

But ZooKeeper does not store any records sent and received using Kafka. The data stored in ZooKeeper is assumed to be non-confidential.

If the data is to be regarded as confidential (for example because topic names contain customer IDs), the only option available for protection is isolating ZooKeeper on the network level and allowing access only to Kafka brokers.

4.8.2. Enabling ZooKeeper ACLs for a new Kafka cluster

This procedure describes how to enable ZooKeeper ACLs in Kafka configuration for a new Kafka cluster. Use this procedure only before the first start of the Kafka cluster. For enabling ZooKeeper ACLs in a cluster that is already running, see Section 4.8.3, "Enabling ZooKeeper ACLs in an existing Kafka cluster" .

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.

- ZooKeeper cluster is configured and running.
- Client-to-server authentication is enabled in ZooKeeper.
- ZooKeeper authentication is enabled in the Kafka brokers.
- Kafka brokers have not yet been started.

Procedure

1. Edit the **/opt/kafka/config/server.properties** Kafka configuration file to set the **zookeeper.set.acl** field to **true** on all cluster nodes.

```
zookeeper.set.acl=true
```

2. Start the Kafka brokers.

4.8.3. Enabling ZooKeeper ACLs in an existing Kafka cluster

This procedure describes how to enable ZooKeeper ACLs in Kafka configuration for a Kafka cluster that is running. Use the **zookeeper-security-migration.sh** tool to set ZooKeeper ACLs on all existing **znodes**. The **zookeeper-security-migration.sh** is available as part of AMQ Streams, and can be found in the **bin** directory.

Prerequisites

- Kafka cluster is configured and running.

Enabling the ZooKeeper ACLs

1. Edit the **/opt/kafka/config/server.properties** Kafka configuration file to set the **zookeeper.set.acl** field to **true** on all cluster nodes.

```
zookeeper.set.acl=true
```

2. Restart all Kafka brokers one by one.
3. Set the ACLs on all existing ZooKeeper **znodes** using the **zookeeper-security-migration.sh** tool.

```
su - kafka
cd /opt/kafka
KAFKA_OPTS="-Djava.security.auth.login.config=./config/jaas.conf"; ./bin/zookeeper-security-migration.sh --zookeeper.acl=secure --zookeeper.connect=<ZooKeeperURL>
exit
```

For example:

```
su - kafka
cd /opt/kafka
KAFKA_OPTS="-Djava.security.auth.login.config=./config/jaas.conf"; ./bin/zookeeper-security-migration.sh --zookeeper.acl=secure --zookeeper.connect=zoo1.my-domain.com:2181
exit
```

4.9. ENCRYPTION AND AUTHENTICATION

AMQ Streams supports encryption and authentication, which is configured as part of the listener configuration.

4.9.1. Listener configuration

Encryption and authentication in Kafka brokers is configured per listener. For more information about Kafka listener configuration, see Section 4.2, “Listeners”.

Each listener in the Kafka broker is configured with its own security protocol. The configuration property **listener.security.protocol.map** defines which listener uses which security protocol. It maps each listener name to its security protocol. Supported security protocols are:

PLAINTEXT

Listener without any encryption or authentication.

SSL

Listener using TLS encryption and, optionally, authentication using TLS client certificates.

SASL_PLAINTEXT

Listener without encryption but with SASL-based authentication.

SASL_SSL

Listener with TLS-based encryption and SASL-based authentication.

Given the following **listeners** configuration:

```
listeners=INT1://:9092,INT2://:9093,REPLICATION://:9094
```

the **listener.security.protocol.map** might look like this:

```
listener.security.protocol.map=INT1:SASL_PLAINTEXT,INT2:SASL_SSL,REPLICATION:SSL
```

This would configure the listener **INT1** to use unencrypted connections with SASL authentication, the listener **INT2** to use encrypted connections with SASL authentication and the **REPLICATION** interface to use TLS encryption (possibly with TLS client authentication). The same security protocol can be used multiple times. The following example is also a valid configuration:

```
listener.security.protocol.map=INT1:SSL,INT2:SSL,REPLICATION:SSL
```

Such a configuration would use TLS encryption and TLS authentication for all interfaces. The following chapters will explain in more detail how to configure TLS and SASL.

4.9.2. TLS Encryption

Kafka supports TLS for encrypting communication with Kafka clients.

In order to use TLS encryption and server authentication, a keystore containing private and public keys has to be provided. This is usually done using a file in the Java Keystore (JKS) format. A path to this file is set in the **ssl.keystore.location** property. The **ssl.keystore.password** property should be used to set the password protecting the keystore. For example:

```
ssl.keystore.location=/path/to/keystore/server-1.jks
ssl.keystore.password=123456
```

In some cases, an additional password is used to protect the private key. Any such password can be set using the **ssl.key.password** property.

Kafka is able to use keys signed by certification authorities as well as self-signed keys. Using keys signed by certification authorities should always be the preferred method. In order to allow clients to verify the identity of the Kafka broker they are connecting to, the certificate should always contain the advertised hostname(s) as its Common Name (CN) or in the Subject Alternative Names (SAN).

It is possible to use different SSL configurations for different listeners. All options starting with **ssl.** can be prefixed with **listener.name.<NameOfTheListener>.**, where the name of the listener has to be always in lower case. This will override the default SSL configuration for that specific listener. The following example shows how to use different SSL configurations for different listeners:

```
listeners=INT1://:9092,INT2://:9093,REPLICATION://:9094
listener.security.protocol.map=INT1:SSL,INT2:SSL,REPLICATION:SSL

# Default configuration - will be used for listeners INT1 and INT2
ssl.keystore.location=/path/to/keystore/server-1.jks
ssl.keystore.password=123456

# Different configuration for listener REPLICATION
listener.name.replication.ssl.keystore.location=/path/to/keystore/server-1.jks
listener.name.replication.ssl.keystore.password=123456
```

Additional TLS configuration options

In addition to the main TLS configuration options described above, Kafka supports many options for fine-tuning the TLS configuration. For example, to enable or disable TLS / SSL protocols or cipher suites:

ssl.cipher.suites

List of enabled cipher suites. Each cipher suite is a combination of authentication, encryption, MAC and key exchange algorithms used for the TLS connection. By default, all available cipher suites are enabled.

ssl.enabled.protocols

List of enabled TLS / SSL protocols. Defaults to **TLSv1.2,TLSv1.1,TLSv1**.

For a complete list of supported Kafka broker configuration options, see Appendix A, *Broker configuration parameters*.

4.9.3. Enabling TLS encryption

This procedure describes how to enable encryption in Kafka brokers.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.

Procedure

1. Generate TLS certificates for all Kafka brokers in your cluster. The certificates should have their advertised and bootstrap addresses in their Common Name or Subject Alternative Name.
2. Edit the **/opt/kafka/config/server.properties** Kafka configuration file on all cluster nodes for the following:
   - Change the **listener.security.protocol.map** field to specify the **SSL** protocol for the listener where you want to use TLS encryption.
   - Set the **ssl.keystore.location** option to the path to the JKS keystore with the broker certificate.
   - Set the **ssl.keystore.password** option to the password you used to protect the keystore. For example:

```
listeners=UNENCRYPTED://:9092,ENCRYPTED://:9093,REPLICATION://:9094
listener.security.protocol.map=UNENCRYPTED:PLAINTEXT,ENCRYPTED:SSL,REPLICATION:PLAINTEXT
ssl.keystore.location=/path/to/keystore/server-1.jks
ssl.keystore.password=123456
```

3. (Re)start the Kafka brokers

Additional resources

- For more information about configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".
- For more information about running a Kafka cluster, see Section 4.5, "Running a multi-node Kafka cluster".
- For more information about configuring TLS encryption in clients, see:
  - Appendix D, *Producer configuration parameters*
  - Appendix C, *Consumer configuration parameters*

4.9.4. Authentication

For authentication, you can use:

- TLS client authentication based on X.509 certificates on encrypted connections
- A supported Kafka SASL (Simple Authentication and Security Layer) mechanism
- OAuth 2.0 token based authentication

4.9.4.1. TLS client authentication

TLS client authentication can be used only on connections which are already using TLS encryption. To use TLS client authentication, a truststore with public keys can be provided to the broker. These keys can be used to authenticate clients connecting to the broker. The truststore should be provided in Java Keystore (JKS) format and should contain public keys of the certification authorities. All clients with public and private keys signed by one of the certification authorities included in the truststore will be

authenticated. The location of the truststore is set using field **ssl.truststore.location**. In case the truststore is password protected, the password should be set in the **ssl.truststore.password** property. For example:

```
ssl.truststore.location=/path/to/keystore/server-1.jks
ssl.truststore.password=123456
```

Once the truststore is configured, TLS client authentication has to be enabled using the **ssl.client.auth** property. This property can be set to one of three different values:

none

TLS client authentication is switched off. (Default value)

requested

TLS client authentication is optional. Clients will be asked to authenticate using TLS client certificate but they can choose not to.

required

Clients are required to authenticate using TLS client certificate.

When a client authenticates using TLS client authentication, the authenticated principal name is the distinguished name from the authenticated client certificate. For example, a user with a certificate which has a distinguished name **CN=someuser** will be authenticated with the following principal **CN=someuser,OU=Unknown,O=Unknown,L=Unknown,ST=Unknown,C=Unknown**. When TLS client authentication is not used and SASL is disabled, the principal name will be **ANONYMOUS**.

4.9.4.2. SASL authentication

SASL authentication is configured using Java Authentication and Authorization Service (JAAS). JAAS is also used for authentication of connections between Kafka and ZooKeeper. JAAS uses its own configuration file. The recommended location for this file is **/opt/kafka/config/jaas.conf**. The file has to be readable by the **kafka** user. When running Kafka, the location of this file is specified using Java system property **java.security.auth.login.config**. This property has to be passed to Kafka when starting the broker nodes:

```
KAFKA_OPTS="-Djava.security.auth.login.config=/path/to/my/jaas.config"; bin/kafka-server-start.sh
```

SASL authentication is supported both through plain unencrypted connections as well as through TLS connections. SASL can be enabled individually for each listener. To enable it, the security protocol in **listener.security.protocol.map** has to be either **SASL_PLAINTEXT** or **SASL_SSL**.

SASL authentication in Kafka supports several different mechanisms:

PLAIN

Implements authentication based on username and passwords. Usernames and passwords are stored locally in Kafka configuration.

SCRAM-SHA-256 and **SCRAM-SHA-512**

Implements authentication using Salted Challenge Response Authentication Mechanism (SCRAM). SCRAM credentials are stored centrally in ZooKeeper. SCRAM can be used in situations where ZooKeeper cluster nodes are running isolated in a private network.

GSSAPI

Implements authentication against a Kerberos server.

WARNING

The **PLAIN** mechanism sends the username and password over the network in an unencrypted format. It should be therefore only be used in combination with TLS encryption.

The SASL mechanisms are configured via the JAAS configuration file. Kafka uses the JAAS context named **KafkaServer**. After they are configured in JAAS, the SASL mechanisms have to be enabled in the Kafka configuration. This is done using the **sasl.enabled.mechanisms** property. This property contains a comma-separated list of enabled mechanisms:

```
sasl.enabled.mechanisms=PLAIN,SCRAM-SHA-256,SCRAM-SHA-512
```

In case the listener used for inter-broker communication is using SASL, the property **sasl.mechanism.inter.broker.protocol** has to be used to specify the SASL mechanism which it should use. For example:

```
sasl.mechanism.inter.broker.protocol=PLAIN
```

The username and password which will be used for the inter-broker communication has to be specified in the **KafkaServer** JAAS context using the field **username** and **password**.

SASL PLAIN

To use the PLAIN mechanism, the usernames and password which are allowed to connect are specified directly in the JAAS context. The following example shows the context configured for SASL PLAIN authentication. The example configures three different users:

- **admin**
- **user1**
- **user2**

```
KafkaServer {
    org.apache.kafka.common.security.plain.PlainLoginModule required
    user_admin="123456"
    user_user1="123456"
    user_user2="123456";
};
```

The JAAS configuration file with the user database should be kept in sync on all Kafka brokers.

When SASL PLAIN is also used for inter-broker authentication, the **username** and **password** properties should be included in the JAAS context:

```
KafkaServer {
    org.apache.kafka.common.security.plain.PlainLoginModule required
    username="admin"
    password="123456"
```

```
    user_admin="123456"
    user_user1="123456"
    user_user2="123456";
};
```

SASL SCRAM

SCRAM authentication in Kafka consists of two mechanisms: **SCRAM-SHA-256** and **SCRAM-SHA-512**. These mechanisms differ only in the hashing algorithm used - SHA-256 versus stronger SHA-512. To enable SCRAM authentication, the JAAS configuration file has to include the following configuration:

```
KafkaServer {
    org.apache.kafka.common.security.scram.ScramLoginModule required;
};
```

When enabling SASL authentication in the Kafka configuration file, both SCRAM mechanisms can be listed. However, only one of them can be chosen for the inter-broker communication. For example:

```
sasl.enabled.mechanisms=SCRAM-SHA-256,SCRAM-SHA-512
sasl.mechanism.inter.broker.protocol=SCRAM-SHA-512
```

User credentials for the SCRAM mechanism are stored in ZooKeeper. The **kafka-configs.sh** tool can be used to manage them. For example, run the following command to add user user1 with password 123456:

```
bin/kafka-configs.sh --bootstrap-server localhost:9092 --alter --add-config 'SCRAM-SHA-256=
[password=123456],SCRAM-SHA-512=[password=123456]' --entity-type users --entity-name user1
```

To delete a user credential use:

```
bin/kafka-configs.sh --bootstrap-server localhost:9092 --alter --delete-config 'SCRAM-SHA-512' --
entity-type users --entity-name user1
```

SASL GSSAPI

The SASL mechanism used for authentication using Kerberos is called **GSSAPI**. To configure Kerberos SASL authentication, the following configuration should be added to the JAAS configuration file:

```
KafkaServer {
    com.sun.security.auth.module.Krb5LoginModule required
    useKeyTab=true
    storeKey=true
    keyTab="/etc/security/keytabs/kafka_server.keytab"
    principal="kafka/kafka1.hostname.com@EXAMPLE.COM";
};
```

The domain name in the Kerberos principal has to be always in upper case.

In addition to the JAAS configuration, the Kerberos service name needs to be specified in the **sasl.kerberos.service.name** property in the Kafka configuration:

```
sasl.enabled.mechanisms=GSSAPI
sasl.mechanism.inter.broker.protocol=GSSAPI
sasl.kerberos.service.name=kafka
```

Multiple SASL mechanisms

Kafka can use multiple SASL mechanisms at the same time. The different JAAS configurations can be all added to the same context:

```
KafkaServer {
    org.apache.kafka.common.security.plain.PlainLoginModule required
    user_admin="123456"
    user_user1="123456"
    user_user2="123456";

    com.sun.security.auth.module.Krb5LoginModule required
    useKeyTab=true
    storeKey=true
    keyTab="/etc/security/keytabs/kafka_server.keytab"
    principal="kafka/kafka1.hostname.com@EXAMPLE.COM";

    org.apache.kafka.common.security.scram.ScramLoginModule required;
};
```

When multiple mechanisms are enabled, clients will be able to choose the mechanism which they want to use.

4.9.5. Enabling TLS client authentication

This procedure describes how to enable TLS client authentication in Kafka brokers.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.
- TLS encryption is enabled.

Procedure

1. Prepare a JKS truststore containing the public key of the certification authority used to sign the user certificates.
2. Edit the **/opt/kafka/config/server.properties** Kafka configuration file on all cluster nodes for the following:
   - Set the **ssl.truststore.location** option to the path to the JKS truststore with the certification authority of the user certificates.
   - Set the **ssl.truststore.password** option to the password you used to protect the truststore.
   - Set the **ssl.client.auth** option to **required**.
     For example:

     ```
     ssl.truststore.location=/path/to/truststore.jks
     ssl.truststore.password=123456
     ssl.client.auth=required
     ```
3. (Re)start the Kafka brokers

Additional resources

- For more information about configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".
- For more information about running a Kafka cluster, see Section 4.5, "Running a multi-node Kafka cluster".
- For more information about configuring TLS encryption in clients, see:
  - Appendix D, *Producer configuration parameters*
  - Appendix C, *Consumer configuration parameters*

4.9.6. Enabling SASL PLAIN authentication

This procedure describes how to enable SASL PLAIN authentication in Kafka brokers.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.

Procedure

1. Edit or create the **/opt/kafka/config/jaas.conf** JAAS configuration file. This file should contain all your users and their passwords. Make sure this file is the same on all Kafka brokers.
   For example:

```
KafkaServer {
   org.apache.kafka.common.security.plain.PlainLoginModule required
   user_admin="123456"
   user_user1="123456"
   user_user2="123456";
};
```

2. Edit the **/opt/kafka/config/server.properties** Kafka configuration file on all cluster nodes for the following:
   - Change the **listener.security.protocol.map** field to specify the **SASL_PLAINTEXT** or **SASL_SSL** protocol for the listener where you want to use SASL PLAIN authentication.
   - Set the **sasl.enabled.mechanisms** option to **PLAIN**.
     For example:

```
listeners=INSECURE://:9092,AUTHENTICATED://:9093,REPLICATION://:9094
listener.security.protocol.map=INSECURE:PLAINTEXT,AUTHENTICATED:SASL_PLAINT
EXT,REPLICATION:PLAINTEXT
sasl.enabled.mechanisms=PLAIN
```

3. (Re)start the Kafka brokers using the KAFKA_OPTS environment variable to pass the JAAS configuration to Kafka brokers.

```
su - kafka
export KAFKA_OPTS="-Djava.security.auth.login.config=/opt/kafka/config/jaas.conf";
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

Additional resources

- For more information about configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".
- For more information about running a Kafka cluster, see Section 4.5, "Running a multi-node Kafka cluster".
- For more information about configuring SASL PLAIN authentication in clients, see:
  - Appendix D, *Producer configuration parameters*
  - Appendix C, *Consumer configuration parameters*

4.9.7. Enabling SASL SCRAM authentication

This procedure describes how to enable SASL SCRAM authentication in Kafka brokers.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.

Procedure

1. Edit or create the **/opt/kafka/config/jaas.conf** JAAS configuration file. Enable the **ScramLoginModule** for the **KafkaServer** context. Make sure this file is the same on all Kafka brokers.
   For example:

```
KafkaServer {
    org.apache.kafka.common.security.scram.ScramLoginModule required;
};
```

2. Edit the **/opt/kafka/config/server.properties** Kafka configuration file on all cluster nodes for the following:
   - Change the **listener.security.protocol.map** field to specify the **SASL_PLAINTEXT** or **SASL_SSL** protocol for the listener where you want to use SASL SCRAM authentication.
   - Set the **sasl.enabled.mechanisms** option to **SCRAM-SHA-256** or **SCRAM-SHA-512**.
     For example:

```
listeners=INSECURE://:9092,AUTHENTICATED://:9093,REPLICATION://:9094
listener.security.protocol.map=INSECURE:PLAINTEXT,AUTHENTICATED:SASL_PLAINTEXT,REPLICATION:PLAINTEXT
sasl.enabled.mechanisms=SCRAM-SHA-512
```

3. (Re)start the Kafka brokers using the KAFKA_OPTS environment variable to pass the JAAS configuration to Kafka brokers.

```
su - kafka
export KAFKA_OPTS="-Djava.security.auth.login.config=/opt/kafka/config/jaas.conf";
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

Additional resources

- For more information about configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".
- For more information about running a Kafka cluster, see Section 4.5, "Running a multi-node Kafka cluster".
- For more information about adding SASL SCRAM users, see Section 4.9.8, "Adding SASL SCRAM users".
- For more information about deleting SASL SCRAM users, see Section 4.9.9, "Deleting SASL SCRAM users".
- For more information about configuring SASL SCRAM authentication in clients, see:
  - Appendix D, *Producer configuration parameters*
  - Appendix C, *Consumer configuration parameters*

4.9.8. Adding SASL SCRAM users

This procedure describes how to add new users for authentication using SASL SCRAM.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.
- SASL SCRAM authentication is enabled.

Procedure

- Use the **kafka-configs.sh** tool to add new SASL SCRAM users.

```
bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --alter --add-config 'SCRAM-SHA-512=[password=<Password>]' --entity-type users --entity-name <Username>
```

  For example:

```
bin/kafka-configs.sh --bootstrap-server localhost:9092 --alter --add-config 'SCRAM-SHA-512=[password=123456]' --entity-type users --entity-name user1
```

Additional resources

- For more information about configuring SASL SCRAM authentication in clients, see:
  - Appendix D, *Producer configuration parameters*
  - Appendix C, *Consumer configuration parameters*

4.9.9. Deleting SASL SCRAM users

This procedure describes how to remove users when using SASL SCRAM authentication.

Prerequisites

- AMQ Streams is installed on all hosts which will be used as Kafka brokers.
- SASL SCRAM authentication is enabled.

Procedure

- Use the **kafka-configs.sh** tool to delete SASL SCRAM users.

```
bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --alter --delete-config 'SCRAM-SHA-512' --entity-type users --entity-name <Username>
```

For example:

```
bin/kafka-configs.sh --bootstrap-server localhost:9092 --alter --delete-config 'SCRAM-SHA-512' --entity-type users --entity-name user1
```

Additional resources

- For more information about configuring SASL SCRAM authentication in clients, see:
  - Appendix D, *Producer configuration parameters*
  - Appendix C, *Consumer configuration parameters*

4.10. USING OAUTH 2.0 TOKEN-BASED AUTHENTICATION

AMQ Streams supports the use of OAuth 2.0 authentication using the *SASL OAUTHBEARER* mechanism.

OAuth 2.0 enables standardized token based authentication and authorization between applications, using a central authorization server to issue tokens that grant limited access to resources.

You can configure OAuth 2.0 authentication, then OAuth 2.0 authorization. OAuth 2.0 authentication can also be used in conjunction with ACL-based Kafka authorization regardless of the authorization server used. Using OAuth 2.0 token-based authentication, application clients can access resources on application servers (called *resource servers*) without exposing account credentials.

The application client passes an access token as a means of authenticating, which application servers can also use to determine the level of access to grant. The authorization server handles the granting of access and inquiries about access.

In the context of AMQ Streams:

- Kafka brokers act as OAuth 2.0 resource servers
- Kafka clients act as OAuth 2.0 application clients

Kafka clients authenticate to Kafka brokers. The brokers and clients communicate with the OAuth 2.0 authorization server, as necessary, to obtain or validate access tokens.

For a deployment of AMQ Streams, OAuth 2.0 integration provides:

- Server-side OAuth 2.0 support for Kafka brokers
- Client-side OAuth 2.0 support for Kafka Mirror Maker, Kafka Connect and the Kafka Bridge

Additional resources

- OAuth 2.0 site

4.10.1. OAuth 2.0 authentication mechanism

The Kafka *SASL OAUTHBEARER* mechanism is used to establish authenticated sessions with a Kafka broker.

A Kafka client initiates a session with the Kafka broker using the *SASL OAUTHBEARER* mechanism for credentials exchange, where credentials take the form of an access token.

Kafka brokers and clients need to be configured to use OAuth 2.0.

4.10.1.1. Configuring OAuth 2.0 with properties or variables

You can configure OAuth 2.0 settings using Java Authentication and Authorization Service (JAAS) properties or environment variables.

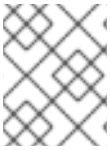
- JAAS properties are configured in the **server.properties** configuration file, and passed as key-values pairs of the **listener.name.*LISTENER-NAME*.oauthbearer.sasl.jaas.config** property.
- If using environment variables, you still need the **listener.name.*LISTENER-NAME*.oauthbearer.sasl.jaas.config** property in the **server.properties** file, but you can omit the other JAAS properties.
  You can use capitalized or upper-case environment variable naming conventions.

The Kafka OAuth 2.0 library uses properties that start with **oauth.** to configure authentication, and properties that start with **strimzi.** to configure OAuth 2.0 authorization.

4.10.2. OAuth 2.0 Kafka broker configuration

Kafka broker configuration for OAuth 2.0 involves:

- Creating the OAuth 2.0 client in the authorization server
- Configuring OAuth 2.0 authentication in the Kafka cluster



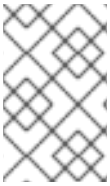
NOTE

In relation to the authorization server, Kafka brokers and Kafka clients are both regarded as OAuth 2.0 clients.

4.10.2.1. OAuth 2.0 client configuration on an authorization server

To configure a Kafka broker to validate the token received during session initiation, the recommended approach is to create a OAuth 2.0 *client* definition in an authorization server, configured as *confidential*, with the following client credentials enabled:

- Client ID of **kafka-broker** (for example)
- Client ID and secret as the authentication mechanism



NOTE

You only need to use a client ID and secret when using a non-public introspection endpoint of the authorization server. The credentials are not typically required when using public authorization server endpoints, as with fast local JWT token validation.

4.10.2.2. OAuth 2.0 authentication configuration in the Kafka cluster

To use OAuth 2.0 authentication in the Kafka cluster, you enable a listener configuration for your Kafka cluster in the Kafka **server.properties** file. A minimum configuration is required. You can also configure a TLS listener, where TLS is used for inter-broker communication.

You can configure the broker for token validation by the authorization server using the:

- *JWKS* endpoint in combination with signed JWT-formatted access tokens
- *Introspection* endpoint

The minimum configuration shown here applies a *global* listener configuration. This means that inter-broker communication goes through the same listener as application clients.

To enable OAuth 2.0 configuration for a specific listener, you specify **listener.name.*LISTENER-NAME*.sasl.enabled.mechanisms** instead of **sasl.enabled.mechanisms**, which is shown in the listener configuration examples below. *LISTENER-NAME* is the name of the listener (case insensitive). In the example below, we name the listener **CLIENT**, so the property name will be **listener.name.client.sasl.enabled.mechanisms**.

Minimum listener configuration for OAuth 2.0 authentication using a JWKS endpoint

```
sasl.enabled.mechanisms=OAUTHBEARER (1)
listeners=CLIENT://0.0.0.0:9092 (2)
listener.security.protocol.map=CLIENT:SASL_PLAINTEXT (3)
listener.name.client.sasl.enabled.mechanisms=OAUTHBEARER (4)
sasl.mechanism.inter.broker.protocol=OAUTHBEARER (5)
inter.broker.listener.name=CLIENT (6)
listener.name.client.oauthbearer.sasl.server.callback.handler.class=io.strimzi.kafka.oauth.server.JaasSe
verOauthValidatorCallbackHandler (7)
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAut
hBearerLoginModule required \ (8)
  oauth.valid.issuer.uri="https://AUTH-SERVER-ADDRESS" \ (9)
  oauth.jwks.endpoint.uri="https://AUTH-SERVER-ADDRESS/jwks" \ (10)
  oauth.username.claim="preferred_username"  \ (11)
  oauth.client.id="kafka-broker" \ (12)
  oauth.client.secret="kafka-secret" \ (13)
  oauth.token.endpoint.uri="https://AUTH-SERVER-ADDRESS/token" ; (14)
listener.name.client.oauthbearer.sasl.login.callback.handler.class=io.strimzi.kafka.oauth.client.JaasClien
OauthLoginCallbackHandler (15)
listener.name.client.oauthbearer.connections.max.reauth.ms=3600000 (16)
```

(1) Enables the *OAUTHBEARER* as *SASL* mechanism for credentials exchange over SASL.

(2) Configures a listener for client applications to connect to. The system **hostname** is used as an advertised hostname, which clients must resolve in order to reconnect. The listener is named **CLIENT** in this example.

3. Specifies the channel protocol for the listener. **SASL_SSL** is for TLS. **SASL_PLAINTEXT** is used for an unencrypted connection (no TLS), but there is risk of eavesdropping and interception at the

4. Specifies *OAUTHBEARER* as *SASL* for the *CLIENT* listener. The client name (***CLIENT***) is usually specified in uppercase in the **listeners** property, and in lowercase for **listener.name** properties (**listener.name.client**). and in lowercase when part of a **listener.name.*client*.*** property.

5. Specifies *OAUTHBEARER* as *SASL* for inter-broker communication.

6. Specifies the listener for inter-broker communication. The specification is required for the configuration to be valid.

7. Configures OAuth 2.0 authentication on the client listener.

8. Configures authentication settings for client and inter-broker communication. The **oauth.client.id**, **oauth.client.secret**, and **auth.token.endpoint.uri** properties relate to inter-broker configuration.

9. A valid issuer URI. Only access tokens issued by this issuer will be accepted. For example, *https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME*.

10. The JWKS endpoint URL. For example, *https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/certs*.

11. The token claim (or key) that contains the actual user name in the token. The user name is the *principal* used to identify the user. The value will depend on the authentication flow and the authorization server used.

12. Client ID of the Kafka broker, which is the same for all brokers. This is the client registered with the authorization server as **kafka-broker**.

13. Secret for the Kafka broker, which is the same for all brokers.

14. The OAuth 2.0 token endpoint URL to your authorization server. For production, always use HTTPs. For example, *https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/token*.

15. Enables (and is only required for) OAuth 2.0 authentication for inter-broker communication.

16. (Optional) Enforces session expiry when token expires, and also activates the Kafka re-authentication mechanism. If the specified value is less than the time left for the access token to expire, then the client will have to re-authenticate before the actual token expiry. By default, the session does not expire when the access token expires, and the client does not attempt re-authentication.

TLS listener configuration for OAuth 2.0 authentication

```
sasl.enabled.mechanisms=
listeners=REPLICATION://kafka:9091,CLIENT://kafka:9092 (1)
listener.security.protocol.map=REPLICATION:SSL,CLIENT:SASL_PLAINTEXT (2)
listener.name.client.sasl.enabled.mechanisms=OAUTHBEARER
inter.broker.listener.name=REPLICATION
listener.name.replication.ssl.keystore.password=KEYSTORE-PASSWORD (3)
listener.name.replication.ssl.truststore.password=TRUSTSTORE-PASSWORD
listener.name.replication.ssl.keystore.type=JKS
listener.name.replication.ssl.truststore.type=JKS
```

```
listener.name.replication.ssl.endpoint.identification.algorithm=HTTPS 4
listener.name.replication.ssl.secure.random.implementation=SHA1PRNG 5
listener.name.replication.ssl.keystore.location=PATH-TO-KEYSTORE 6
listener.name.replication.ssl.truststore.location=PATH-TO-TRUSTSTORE 7
listener.name.replication.ssl.client.auth=required 8
listener.name.client.oauthbearer.sasl.server.callback.handler.class=io.strimzi.kafka.oauth.server.JaasSe
verOauthValidatorCallbackHandler
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAut
hBearerLoginModule required \
  oauth.valid.issuer.uri="https://AUTH-SERVER-ADDRESS" \
  oauth.jwks.endpoint.uri="https://AUTH-SERVER-ADDRESS/jwks" \
  oauth.username.claim="preferred_username" ; 9
```

1. Separate configurations are required for inter-broker communication and client applications.
2. Configures the *REPLICATION* listener to use TLS, and the *CLIENT* listener to use SASL over an unencrypted channel. The client could use an encrypted channel (**SASL_SSL**) in a production environment.
3. The **ssl.** properties define the TLS configuration.
4. Random number generator implementation. If not set, the Java platform SDK default is used.
5. Hostname verification. If set to an empty string, the hostname verification is turned off. If not set, the default value is HTTPS, which enforces hostname verification for server certificates.
6. Path to the keystore for the listener.
7. Path to the truststore for the listener.
8. Specifies that clients of the *REPLICATION* listener have to authenticate with a client certificate when establishing a TLS connection (used for inter-broker connectivity).
9. Configures the *CLIENT* listener for OAuth 2.0. Connectivity with the authorization server should use secure HTTPS connections.

4.10.2.3. Fast local JWT token validation configuration

Fast local JWT token validation checks a JWT token signature locally.

The local check ensures that a token:

- Conforms to type by containing a (*typ*) claim value of **Bearer** for an access token
- Is valid (not expired)
- Has an issuer that matches a **validIssuerURI**

You specify a *valid issuer URI* when you configure the listener, so that any tokens not issued by the authorization server are rejected.

The authorization server does not need to be contacted during fast local JWT token validation. You activate fast local JWT token validation by specifying a *JWKs endpoint URI* exposed by the OAuth 2.0 authorization server. The endpoint contains the public keys used to validate signed JWT tokens, which are sent as credentials by Kafka clients.

NOTE

All communication with the authorization server should be performed using HTTPS.

For a TLS listener, you can configure a certificate *truststore* and point to the truststore file.

Example properties for fast local JWT token validation

```
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required \
  oauth.valid.issuer.uri="https://AUTH-SERVER-ADDRESS" \ 1
  oauth.jwks.endpoint.uri="https://AUTH-SERVER-ADDRESS/jwks" \ 2
  oauth.jwks.refresh.seconds="300" \ 3
  oauth.jwks.refresh.min.pause.seconds="1" \ 4
  oauth.jwks.expiry.seconds="360" \ 5
  oauth.username.claim="preferred_username" \ 6
  oauth.ssl.truststore.location="PATH-TO-TRUSTSTORE-P12-FILE" \ 7
  oauth.ssl.truststore.password="TRUSTSTORE-PASSWORD" \ 8
  oauth.ssl.truststore.type="PKCS12" ; 9
```

1. A valid issuer URI. Only access tokens issued by this issuer will be accepted. For example, *https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME*.
2. The JWKS endpoint URL. For example, *https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/certs*.
3. The period between endpoint refreshes (default 300).
4. The minimum pause in seconds between consecutive attempts to refresh JWKS public keys. When an unknown signing key is encountered, the JWKS keys refresh is scheduled outside the regular periodic schedule with at least the specified pause since the last refresh attempt. The refreshing of keys follows the rule of exponential backoff, retrying on unsuccessful refreshes with ever increasing pause, until it reaches **oauth.jwks.refresh.seconds**. The default value is 1.
5. The duration the JWKs certificates are considered valid before they expire. Default is **360** seconds. If you specify a longer time, consider the risk of allowing access to revoked certificates.
6. The token claim (or key) that contains the actual user name in the token. The user name is the *principal* used to identify the user. The value will depend on the authentication flow and the authorization server used.
7. The location of the truststore used in the TLS configuration.
8. Password to access the truststore.
9. The truststore type in PKCS #12 format.

4.10.2.4. OAuth 2.0 introspection endpoint configuration

Token validation using an OAuth 2.0 introspection endpoint treats a received access token as opaque. The Kafka broker sends an access token to the introspection endpoint, which responds with the token information necessary for validation. Importantly, it returns up-to-date information if the specific access token is valid, and also information about when the token expires.

To configure OAuth 2.0 introspection-based validation, you specify an *introspection endpoint URI* rather than the JWKs endpoint URI specified for fast local JWT token validation. Depending on the authorization server, you typically have to specify a *client ID* and *client secret*, because the introspection endpoint is usually protected.

Example properties for an introspection endpoint

```
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required \
  oauth.introspection.endpoint.uri="https://AUTH-SERVER-ADDRESS/introspection" \ 1
  oauth.client.id="kafka-broker" \ 2
  oauth.client.secret="kafka-broker-secret" \ 3
  oauth.ssl.truststore.location="PATH-TO-TRUSTSTORE-P12-FILE" \ 4
  oauth.ssl.truststore.password="TRUSTSTORE-PASSWORD" \ 5
  oauth.ssl.truststore.type="PKCS12" \ 6
  oauth.username.claim="preferred_username" ; 7
```

1. The OAuth 2.0 introspection endpoint URI. For example, *https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/token/introspect*.
2. Client ID of the Kafka broker.
3. Secret for the Kafka broker.
4. The location of the truststore used in the TLS configuration.
5. Password to access the truststore.
6. The truststore type in PKCS #12 format.
7. The token claim (or key) that contains the actual user name in the token. The user name is the *principal* used to identify the user. The value of **oauth.username.claim** depends on the authorization server used.

4.10.3. Session re-authentication for Kafka brokers

The Kafka *SASL OAUTHBEARER* mechanism, which is used for OAuth 2.0 authentication in AMQ Streams, supports a Kafka feature called the *re-authentication* mechanism.

When the re-authentication mechanism is enabled through a listener configuration, the broker's authenticated session expires when the access token expires. The client must then re-authenticate to the existing session by sending a new, valid access token to the broker, without dropping the connection.

If token validation is successful, a new client session is started using the existing connection. If the client fails to re-authenticate, the broker will close the connection if further attempts are made to send or receive messages. Java clients that use Kafka client library 2.2 or later automatically re-authenticate if the re-authentication mechanism is enabled on the broker.

You enable session re-authentication for a Kafka broker in the Kafka **server.properties** file. Set the **connections.max.reauth.ms** property for a TLS listener with OAUTHBEARER enabled as the SASL mechanism.

You can specify session re-authentication per listener. For example:

```
listener.name.client.oauthbearer.connections.max.reauth.ms=3600000
```

Session re-authentication is supported for both types of token validation (fast local JWT and introspection endpoint). For an example configuration, see Section 4.10.6.2, "Configuring OAuth 2.0 support for Kafka brokers".

For more information about the re-authentication mechanism, which was added in Kafka version 2.2, see KIP-368.

Additional resources

- Section 4.10.2, "OAuth 2.0 Kafka broker configuration"
- Section 4.10.6.2, "Configuring OAuth 2.0 support for Kafka brokers"

4.10.4. OAuth 2.0 Kafka client configuration

A Kafka client is configured with either:

- The Credentials required to obtain a valid access token from an authorization server (client ID and Secret)
- A valid long-lived access token or refresh token, obtained using tools provided by an authorization server

Credentials are never sent to the Kafka broker. The only information ever sent to the Kafka broker is an access token. When a client obtains an access token, no further communication with the authorization server is needed.

The simplest mechanism is authentication with a client ID and Secret. Using a long-lived access token, or a long-lived refresh token, adds more complexity because there is additional dependency on authorization server tools.

NOTE

If you are using long-lived access tokens, you may need to configure the client in the authorization server to increase the maximum lifetime of the token.

If the Kafka client is not configured with an access token directly, the client exchanges credentials for an access token during Kafka session initiation by contacting the authorization server. The Kafka client exchanges either:

- Client ID and Secret
- Client ID, refresh token, and (optionally) a Secret

4.10.5. OAuth 2.0 client authentication flow

In this section, we explain and visualize the communication flow between Kafka client, Kafka broker, and authorization server during Kafka session initiation. The flow depends on the client and server configuration.

When a Kafka client sends an access token as credentials to a Kafka broker, the token needs to be validated.

Depending on the authorization server used, and the configuration options available, you may prefer to use:

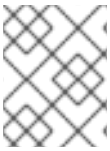
- Fast local token validation based on JWT signature checking and local token introspection, without contacting the authorization server
- An OAuth 2.0 introspection endpoint provided by the authorization server

Using fast local token validation requires the authorization server to provide a JWKS endpoint with public certificates that are used to validate signatures on the tokens.

Another option is to use an OAuth 2.0 introspection endpoint on the authorization server. Each time a new Kafka broker connection is established, the broker passes the access token received from the client to the authorization server, and checks the response to confirm whether or not the token is valid.

Kafka client credentials can also be configured for:

- Direct local access using a previously generated long-lived access token
- Contact with the authorization server for a new access token to be issued



NOTE

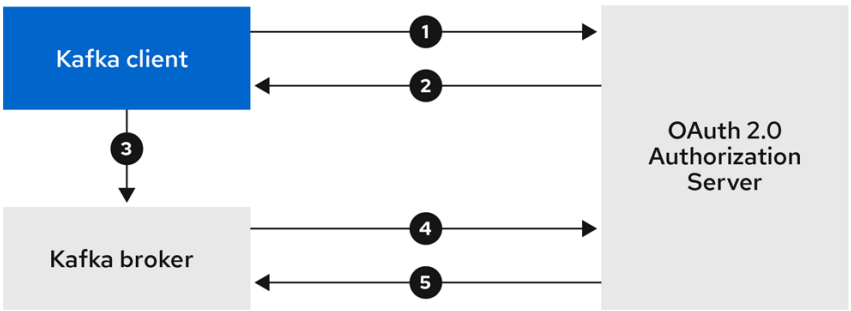
An authorization server might only allow the use of opaque access tokens, which means that local token validation is not possible.

4.10.5.1. Example client authentication flows

Here you can see the communication flows, for different configurations of Kafka clients and brokers, during Kafka session authentication.

- Client using client ID and secret, with broker delegating validation to authorization server
- Client using client ID and secret, with broker performing fast local token validation
- Client using long-lived access token, with broker delegating validation to authorization server
- Client using long-lived access token, with broker performing fast local validation

Client using client ID and secret, with broker delegating validation to authorization server



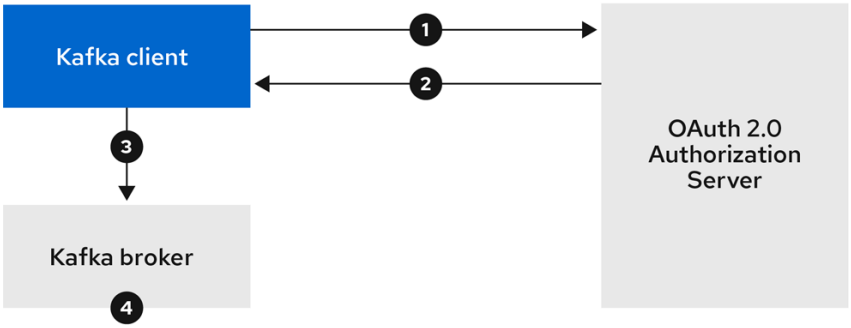
1. Kafka client requests access token from authorization server, using client ID and secret, and optionally a refresh token.
2. Authorization server generates a new access token.

3. Kafka client authenticates with the Kafka broker using the *SASL OAUTHBEARER* mechanism to pass the access token.

4. Kafka broker validates the access token by calling a token introspection endpoint on authorization server, using its own client ID and secret.

5. Kafka client session is established if the token is valid.

Client using client ID and secret, with broker performing fast local token validation



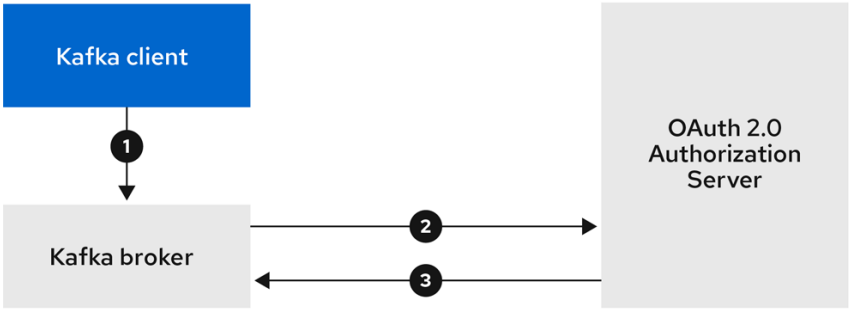
1. Kafka client authenticates with authorization server from the token endpoint, using a client ID and secret, and optionally a refresh token.

2. Authorization server generates a new access token.

3. Kafka client authenticates with the Kafka broker using the *SASL OAUTHBEARER* mechanism to pass the access token.

4. Kafka broker validates the access token locally using a JWT token signature check, and local token introspection.

Client using long-lived access token, with broker delegating validation to authorization server

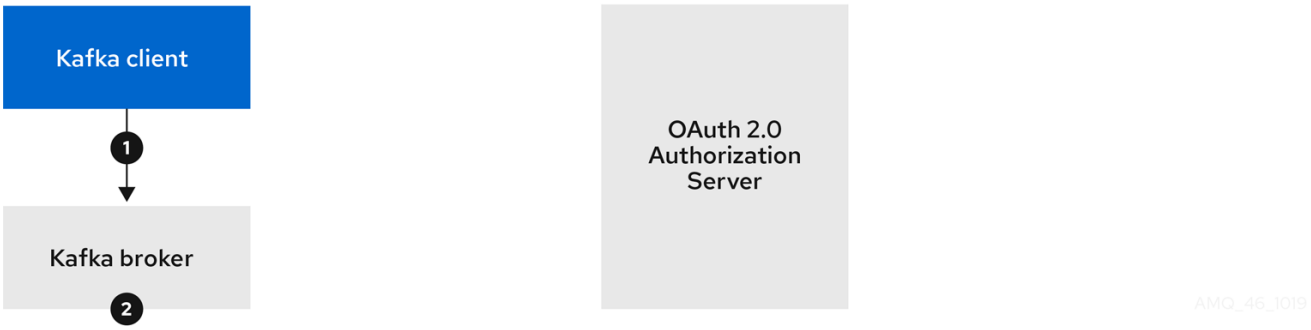


1. Kafka client authenticates with the Kafka broker using the *SASL OAUTHBEARER* mechanism to pass the long-lived access token.

2. Kafka broker validates the access token by calling a token introspection endpoint on authorization server, using its own client ID and secret.

3. Kafka client session is established if the token is valid.

Client using long-lived access token, with broker performing fast local validation



1. Kafka client authenticates with the Kafka broker using the *SASL OAUTHBEARER* mechanism to pass the long-lived access token.
2. Kafka broker validates the access token locally using JWT token signature check, and local token introspection.

WARNING

Fast local JWT token signature validation is suitable only for short-lived tokens as there is no check with the authorization server if a token has been revoked. Token expiration is written into the token, but revocation can happen at any time, so cannot be accounted for without contacting the authorization server. Any issued token would be considered valid until it expires.

4.10.6. Configuring OAuth 2.0 authentication

OAuth 2.0 is used for interaction between Kafka clients and AMQ Streams components.

In order to use OAuth 2.0 for AMQ Streams, you must:

1. Configure an OAuth 2.0 authorization server for the AMQ Streams cluster and Kafka clients
2. Deploy or update the Kafka cluster with Kafka broker listeners configured to use OAuth 2.0
3. Update your Java-based Kafka clients to use OAuth 2.0

4.10.6.1. Configuring Red Hat Single Sign-On as an OAuth 2.0 authorization server

This procedure describes how to deploy Red Hat Single Sign-On as an authorization server and configure it for integration with AMQ Streams.

The authorization server provides a central point for authentication and authorization, and management of users, clients, and permissions. Red Hat Single Sign-On has a concept of realms where a *realm* represents a separate set of users, clients, permissions, and other configuration. You can use a default *master realm*, or create a new one. Each realm exposes its own OAuth 2.0 endpoints, which means that application clients and application servers all need to use the same realm.

To use OAuth 2.0 with AMQ Streams, you need a deployment of an authorization server to be able to create and manage authentication realms.

NOTE

If you already have Red Hat Single Sign-On deployed, you can skip the deployment step and use your current deployment.

Before you begin

You will need to be familiar with using Red Hat Single Sign-On.

For installation and administration instructions, see:

- Server Installation and Configuration Guide
- Server Administration Guide

Prerequisites

- AMQ Streams and Kafka are running

For the Red Hat Single Sign-On deployment:

- Check the Red Hat Single Sign-On Supported Configurations

Procedure

1. Install Red Hat Single Sign-On.
   You can install from a ZIP file or by using an RPM.
2. Log in to the Red Hat Single Sign-On Admin Console to create the OAuth 2.0 policies for AMQ Streams.
   Login details are provided when you deploy Red Hat Single Sign-On.
3. Create and enable a realm.
   You can use an existing master realm.
4. Adjust the session and token timeouts for the realm, if required.
5. Create a client called **kafka-broker**.
6. From the **Settings** tab, set:
   - **Access Type** to **Confidential**
   - **Standard Flow Enabled** to **OFF** to disable web login for this client
   - **Service Accounts Enabled** to **ON** to allow this client to authenticate in its own name
7. Click **Save** before continuing.
8. From the **Credentials** tab, take a note of the secret for using in your AMQ Streams Kafka cluster configuration.
9. Repeat the client creation steps for any application client that will connect to your Kafka brokers.
   Create a definition for each new client.

   You will use the names as client IDs in your configuration.

What to do next

After deploying and configuring the authorization server, configure the Kafka brokers to use OAuth 2.0 .

4.10.6.2. Configuring OAuth 2.0 support for Kafka brokers

This procedure describes how to configure Kafka brokers so that the broker listeners are enabled to use OAuth 2.0 authentication using an authorization server.

We advise use of OAuth 2.0 over an encrypted interface through configuration of TLS listeners. Plain listeners are not recommended.

Configure the Kafka brokers using properties that support your chosen authorization server, and the type of authorization you are implementing.

Before you start

For more information on the configuration and authentication of Kafka broker listeners, see:

- Listeners
- Encryption and authentication

For a description of the properties used in the listener configuration, see:

- OAuth 2.0 Kafka broker configuration

Prerequisites

- AMQ Streams and Kafka are running
- An OAuth 2.0 authorization server is deployed

Procedure

1. Configure the Kafka broker listener configuration in the **server.properties** file.
   For example:

```
sasl.enabled.mechanisms=OAUTHBEARER
listeners=CLIENT://0.0.0.0:9092
listener.security.protocol.map=CLIENT:SASL_PLAINTEXT
listener.name.client.sasl.enabled.mechanisms=OAUTHBEARER
sasl.mechanism.inter.broker.protocol=OAUTHBEARER
inter.broker.listener.name=CLIENT
listener.name.client.oauthbearer.sasl.server.callback.handler.class=io.strimzi.kafka.oauth.server
JaasServerOauthValidatorCallbackHandler
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbear
er.OAuthBearerLoginModule required ;
listener.name.client.oauthbearer.sasl.login.callback.handler.class=io.strimzi.kafka.oauth.client.J
asClientOauthLoginCallbackHandler
```

2. Configure broker connection settings as part of the **listener.name.client.oauthbearer.sasl.jaas.config**.
   The examples here show connection configuration options.

   Example 1: Local token validation using a JWKS endpoint configuration

```
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbear
er.OAuthBearerLoginModule required \
  oauth.valid.issuer.uri="https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME" \
  oauth.jwks.endpoint.uri="https://AUTH-SERVER-ADDRESS/auth/realms/REALM-
NAME/protocol/openid-connect/certs" \
  oauth.jwks.refresh.seconds="300" \
  oauth.jwks.refresh.min.pause.seconds="1" \
  oauth.jwks.expiry.seconds="360" \
  oauth.username.claim="preferred_username" \
  oauth.ssl.truststore.location="PATH-TO-TRUSTSTORE-P12-FILE" \
  oauth.ssl.truststore.password="TRUSTSTORE-PASSWORD" \
  oauth.ssl.truststore.type="PKCS12" ;
listener.name.client.oauthbearer.connections.max.reauth.ms=3600000
```

Example 2: Delegating token validation to the authorization server through the OAuth 2.0 introspection endpoint

```
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbear
er.OAuthBearerLoginModule required \
  oauth.introspection.endpoint.uri="https://AUTH-SERVER-ADDRESS/auth/realms/REALM-
NAME/protocol/openid-connect/introspection" \
  # ...
```

3. If required, configure access to the authorization server.
   This step is normally required for a production environment, unless a technology like *service mesh* is used to configure secure channels outside containers.

   a. Provide a custom truststore for connecting to a secured authorization server. SSL is always required for access to the authorization server.
      Set properties to configure the truststore.

      For example:

      ```
      listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauth
      bearer.OAuthBearerLoginModule required \
        # ...
        oauth.client.id="kafka-broker" \
        oauth.client.secret="kafka-broker-secret" \
        oauth.ssl.truststore.location="PATH-TO-TRUSTSTORE-P12-FILE" \
        oauth.ssl.truststore.password="TRUSTSTORE-PASSWORD" \
        oauth.ssl.truststore.type="PKCS12" ;
      ```

   b. If the certificate hostname does not match the access URL hostname, you can turn off certificate hostname validation:

      ```
      oauth.ssl.endpoint.identification.algorithm=""
      ```

      The check ensures that client connection to the authorization server is authentic. You may wish to turn off the validation in a non-production environment.

4. Configure additional properties according to your chosen authentication flow.

   ```
   listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbear
   er.OAuthBearerLoginModule required \
   ```

```
# ...
oauth.token.endpoint.uri="https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/token" \ 1
oauth.valid.issuer.uri="https://https://AUTH-SERVER-ADDRESS/auth/REALM-NAME" \ 2
oauth.client.id="kafka-broker" \ 3
oauth.client.secret="kafka-broker-secret" \ 4

oauth.refresh.token="REFRESH-TOKEN-FOR-KAFKA-BROKERS" \ 5
oauth.access.token="ACCESS-TOKEN-FOR-KAFKA-BROKERS" ; 6
```

1. The OAuth 2.0 token endpoint URL to your authorization server. For production, always use HTTPs. Required when **KeycloakRBACAuthorizer** is used, or an OAuth 2.0 enabled listener is used for inter-broker communication.
2. A valid issuer URI. Only access tokens issued by this issuer will be accepted. (Always required.)
3. The configured client ID of the Kafka broker, which is the same for all brokers. This is the client registered with the authorization server as **kafka-broker**. Required when an introspection endpoint is used for token validation, or when **KeycloakRBACAuthorizer** is used.
4. The configured secret for the Kafka broker, which is the same for all brokers. When the broker must authenticate to the authorization server, either a client secret, access token or a refresh token has to be specified.
5. (Optional) A long-lived refresh token for Kafka brokers.
6. (Optional) A long-lived access token for Kafka brokers.

5. Depending on how you apply OAuth 2.0 authentication, and the type of authorization server being used, add additional configuration settings:

```
listener.name.client.oauthbearer.sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required \
# ...
oauth.check.issuer=false \ 1
oauth.fallback.username.claim="CLIENT-ID" \ 2
oauth.fallback.username.prefix="CLIENT-ACCOUNT" \ 3
oauth.valid.token.type="bearer" \ 4
oauth.userinfo.endpoint.uri="https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/userinfo" ; 5
```

1. If your authorization server does not provide an **iss** claim, it is not possible to perform an issuer check. In this situation, set **oauth.check.issuer** to **false** and do not specify a **oauth.valid.issuer.uri**. Default is **true**.
2. An authorization server may not provide a single attribute to identify both regular users and clients. When a client authenticates in its own name, the server might provide a *client ID*. When a user authenticates using a username and password, to obtain a refresh token or an access token, the server might provide a *username* attribute in addition to a client ID. Use this fallback option to specify the username claim (attribute) to use if a primary user ID attribute is not available.

3 In situations where **oauth.fallback.username.claim** is applicable, it may also be necessary to prevent name collisions between the values of the username claim, and those of the

4 (Only applicable when using **oauth.introspection.endpoint.uri**) Depending on the authorization server you are using, the introspection endpoint may or may not return the *token type* attribute, or it may contain different values. You can specify a valid token type value that the response from the introspection endpoint has to contain.

5 (Only applicable when using **oauth.introspection.endpoint.uri**) The authorization server may be configured or implemented in such a way to not provide any identifiable information in an introspection endpoint response. In order to obtain the user ID, you can configure the URI of the **userinfo** endpoint as a fallback. The **oauth.fallback.username.claim**, **oauth.fallback.username.claim**, and **oauth.fallback.username.prefix** settings are applied to the response of the **userinfo** endpoint.

What to do next

- Configure your Kafka clients to use OAuth 2.0

4.10.6.3. Configuring Kafka Java clients to use OAuth 2.0

This procedure describes how to configure Kafka producer and consumer APIs to use OAuth 2.0 for interaction with Kafka brokers.

Add a client callback plugin to your *pom.xml* file, and configure the system properties.

Prerequisites

- AMQ Streams and Kafka are running
- An OAuth 2.0 authorization server is deployed and configured for OAuth access to Kafka brokers
- Kafka brokers are configured for OAuth 2.0

Procedure

1. Add the client library with OAuth 2.0 support to the **pom.xml** file for the Kafka client:

```
<dependency>
 <groupId>io.strimzi</groupId>
 <artifactId>kafka-oauth-client</artifactId>
 <version>0.6.1.redhat-00003</version>
</dependency>
```

2. Configure the system properties for the callback:
   For example:

```
System.setProperty(ClientConfig.OAUTH_TOKEN_ENDPOINT_URI, “https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/token”); 1
System.setProperty(ClientConfig.OAUTH_CLIENT_ID, "CLIENT-NAME"); 2
```

```
System.setProperty(ClientConfig.OAUTH_CLIENT_SECRET, "CLIENT_SECRET"); 3
System.setProperty(ClientConfig.OAUTH_SCOPE, "SCOPE-VALUE") 4
```

1. URI of the authorization server token endpoint.
2. Client ID, which is the name used when creating the *client* in the authorization server.
3. Client secret created when creating the *client* in the authorization server.
4. (Optional) The **scope** for requesting the token from the token endpoint. An authorization server may require a client to specify the scope.

3. Enable the *SASL OAUTHBEARER* mechanism on a TLS encrypted connection in the Kafka client configuration:
   For example:

```
props.put("sasl.jaas.config",
"org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required;");
props.put("security.protocol", "SASL_SSL"); 1
props.put("sasl.mechanism", "OAUTHBEARER");
props.put("sasl.login.callback.handler.class",
"io.strimzi.kafka.oauth.client.JaasClientOauthLoginCallbackHandler");
```

1. Here we use **SASL_SSL** for use over TLS connections. Use **SASL_PLAINTEXT** over unencrypted connections.

4. Verify that the Kafka client can access the Kafka brokers.

4.11. USING OAUTH 2.0 TOKEN-BASED AUTHORIZATION

If you are using OAuth 2.0 with Red Hat Single Sign-On for token-based authentication, you can also use Red Hat Single Sign-On to configure authorization rules to constrain client access to Kafka brokers. Authentication establishes the identity of a user. Authorization decides the level of access for that user.

AMQ Streams supports the use of OAuth 2.0 token-based authorization through Red Hat Single Sign-On Authorization Services, which allows you to manage security policies and permissions centrally.

Security policies and permissions defined in Red Hat Single Sign-On are used to grant access to resources on Kafka brokers. Users and clients are matched against policies that permit access to perform specific actions on Kafka brokers.

Kafka allows all users full access to brokers by default, and also provides the **AclAuthorizer** plugin to configure authorization based on Access Control Lists (ACLs).

ZooKeeper stores ACL rules that grant or deny access to resources based on *username*. However, OAuth 2.0 token-based authorization with Red Hat Single Sign-On offers far greater flexibility on how you wish to implement access control to Kafka brokers. In addition, you can configure your Kafka brokers to use OAuth 2.0 authorization and ACLs.

Additional resources

- Using OAuth 2.0 token-based authentication

- Kafka Authorization
- Red Hat Single Sign-On documentation

4.11.1. OAuth 2.0 authorization mechanism

OAuth 2.0 authorization in AMQ Streams uses Red Hat Single Sign-On server Authorization Services REST endpoints to extend token-based authentication with Red Hat Single Sign-On by applying defined security policies on a particular user, and providing a list of permissions granted on different resources for that user. Policies use roles and groups to match permissions to users. OAuth 2.0 authorization enforces permissions locally based on the received list of grants for the user from Red Hat Single Sign-On Authorization Services.

4.11.1.1. Kafka broker custom authorizer

A Red Hat Single Sign-On *authorizer* (**KeycloakRBACAuthorizer**) is provided with AMQ Streams. To be able to use the Red Hat Single Sign-On REST endpoints for Authorization Services provided by Red Hat Single Sign-On, you configure a custom authorizer on the Kafka broker.

The authorizer fetches a list of granted permissions from the authorization server as needed, and enforces authorization locally on the Kafka Broker, making rapid authorization decisions for each client request.

4.11.2. Configuring OAuth 2.0 authorization support

This procedure describes how to configure Kafka brokers to use OAuth 2.0 authorization using Red Hat Single Sign-On Authorization Services.

Before you begin

Consider the access you require or want to limit for certain users. You can use a combination of Red Hat Single Sign-On *groups*, *roles*, *clients*, and *users* to configure access in Red Hat Single Sign-On.

Typically, groups are used to match users based on organizational departments or geographical locations. And roles are used to match users based on their function.

With Red Hat Single Sign-On, you can store users and groups in LDAP, whereas clients and roles cannot be stored this way. Storage and access to user data may be a factor in how you choose to configure authorization policies.

NOTE

Super users always have unconstrained access to a Kafka broker regardless of the authorization implemented on the Kafka broker.

Prerequisites

- AMQ Streams must be configured to use OAuth 2.0 with Red Hat Single Sign-On for token-based authentication. You use the same Red Hat Single Sign-On server endpoint when you set up authorization.
- You need to understand how to manage policies and permissions for Red Hat Single Sign-On Authorization Services, as described in the Red Hat Single Sign-On documentation .

Procedure

1. Access the Red Hat Single Sign-On Admin Console or use the Red Hat Single Sign-On Admin CLI to enable Authorization Services for the Kafka broker client you created when setting up OAuth 2.0 authentication.

2. Use Authorization Services to define resources, authorization scopes, policies, and permissions for the client.

3. Bind the permissions to users and clients by assigning them roles and groups.

4. Configure the Kafka brokers to use Red Hat Single Sign-On authorization.
   Add the following to the Kafka **server.properties** configuration file to install the authorizer in Kafka:

```
authorizer.class.name=io.strimzi.kafka.oauth.server.authorizer.KeycloakRBACAuthorizer
principal.builder.class=io.strimzi.kafka.oauth.server.authorizer.JwtKafkaPrincipalBuilder
```

5. Add configuration for the Kafka brokers to access the authorization server and Authorization Services.
   Here we show example configuration added as additional properties to **server.properties**, but you can also define them as environment variables using capitalized or upper-case naming conventions.

```
strimzi.authorization.token.endpoint.uri="https://AUTH-SERVER-ADDRESS/auth/realms/REALM-NAME/protocol/openid-connect/token" (1)
strimzi.authorization.client.id="kafka" (2)
```

   (1) The OAuth 2.0 token endpoint URL to Red Hat Single Sign-On. For production, always use HTTPs.

   (2) The client ID of the OAuth 2.0 client definition in Red Hat Single Sign-On that has Authorization Services enabled. Typically, **kafka** is used as the ID.

6. (Optional) Add configuration for specific Kafka clusters.
   For example:

```
strimzi.authorization.kafka.cluster.name="kafka-cluster" (1)
```

   (1) The name of a specific Kafka cluster. Names are used to target permissions, making it possible to manage multiple clusters within the same Red Hat Single Sign-On realm. The default value is **kafka-cluster**.

7. (Optional) Delegate to simple authorization.
   For example:

```
strimzi.authorization.delegate.to.kafka.acl="false" (1)
```

   (1) Delegate authorization to Kafka **AclAuthorizer** if access is denied by Red Hat Single Sign-On Authorization Services policies. The default is **false**.

8. (Optional) Add configuration for TLS connection to the authorization server.
   For example:

```
strimzi.authorization.ssl.truststore.location=<path-to-truststore> 1
strimzi.authorization.ssl.truststore.password=<my-truststore-password> 2
strimzi.authorization.ssl.truststore.type=JKS 3
strimzi.authorization.ssl.secure.random.implementation=SHA1PRNG 4
strimzi.authorization.ssl.endpoint.identification.algorithm=HTTPS 5
```

1. The path to the truststore that contain the certificates.
2. The password for the truststore.
3. The truststore type. If not set, the default Java keystore type is used.
4. Random number generator implementation. If not set, the Java platform SDK default is used.
5. Hostname verification. If set to an empty string, the hostname verification is turned off. If not set, the default value is **HTTPS**, which enforces hostname verification for server certificates.

9. (Optional) Configure the refresh of grants from the authorization server. The grants refresh job works by enumerating the active tokens and requesting the latest grants for each.
For example:

```
strimzi.authorization.grants.refresh.period.seconds="120" 1
strimzi.authorization.grants.refresh.pool.size="10" 2
```

1. Specifies how often the list of grants from the authorization server is refreshed (once per minute by default). To turn grants refresh off for debugging purposes, set to **"0"**.
2. Specifies the size of the thread pool (the degree of parallelism) used by the grants refresh job. The default value is **"5"**.

10. Verify the configured permissions by accessing Kafka brokers as clients or users with specific roles, making sure they have the necessary access, or do not have the access they are not supposed to have.

4.12. USING OPA POLICY-BASED AUTHORIZATION

Open Policy Agent (OPA) is an open-source policy engine. You can integrate OPA with AMQ Streams to act as a policy-based authorization mechanism for permitting client operations on Kafka brokers.

When a request is made from a client, OPA will evaluate the request against policies defined for Kafka access, then allow or deny the request.

NOTE

Red Hat does not support the OPA server.

Additional resources

- Open Policy Agent website

4.12.1. Defining OPA policies

Before integrating OPA with AMQ Streams, consider how you will define policies to provide fine-grained access controls.

You can define access control for Kafka clusters, consumer groups and topics. For instance, you can define an authorization policy that allows write access from a producer client to a specific broker topic.

For this, the policy might specify the:

- **User principal** and **host address** associated with the producer client
- **Operations** allowed for the client
- **Resource type** (**topic**) and **resource name** the policy applies to

Allow and deny decisions are written into the policy, and a response is provided based on the request and client identification data provided.

In our example the producer client would have to satisfy the policy to be allowed to write to the topic.

4.12.2. Connecting to the OPA

To enable Kafka to access the OPA policy engine to query access control policies, , you configure a custom OPA authorizer plugin (**kafka-authorizer-opa-*VERSION*.jar**) in your Kafka **server.properties** file.

When a request is made by a client, the OPA policy engine is queried by the plugin using a specified URL address and a REST endpoint, which must be the name of the defined policy.

The plugin provides the details of the client request — user principal, operation, and resource — in JSON format to be checked against the policy. The details will include the unique identity of the client; for example, taking the distinguished name from the client certificate if TLS authentication is used.

OPA uses the data to provide a response — either *true* or *false* — to the plugin to allow or deny the request.

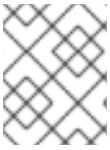
4.12.3. Configuring OPA authorization support

This procedure describes how to configure Kafka brokers to use OPA authorization.

Before you begin

Consider the access you require or want to limit for certain users. You can use a combination of *users* and Kafka *resources* to define OPA policies.

It is possible to set up OPA to load user information from an LDAP data source.



NOTE

Super users always have unconstrained access to a Kafka broker regardless of the authorization implemented on the Kafka broker.

Prerequisites

- An OPA server must be available for connection.

- OPA authorizer plugin for Kafka

Procedure

1. Write the OPA policies required for authorizing client requests to perform operations on the Kafka brokers.
   See Defining OPA policies.

   Now configure the Kafka brokers to use OPA.

2. Install the OPA authorizer plugin for Kafka.
   See Connecting to the OPA.

   Make sure that the plugin files are included in the Kafka classpath.

3. Add the following to the Kafka **server.properties** configuration file to enable the OPA plugin:

   ```
   authorizer.class.name: com.bisnode.kafka.authorization.OpaAuthorizer
   ```

4. Add further configuration to **server.properties** for the Kafka brokers to access the OPA policy engine and policies.
   For example:

   ```
   opa.authorizer.url=https://OPA-ADDRESS/allow (1)
   opa.authorizer.allow.on.error=false (2)
   opa.authorizer.cache.initial.capacity=50000 (3)
   opa.authorizer.cache.maximum.size=50000 (4)
   opa.authorizer.cache.expire.after.seconds=600000 (5)
   super.users=User:alice;User:bob (6)
   ```

   (1) (Required) The OAuth 2.0 token endpoint URL for the policy the authorizer plugin will query. In this example, the policy is called **allow**.

   (2) Flag to specify whether a client is allowed or denied access by default if the authorizer plugin fails to connect with the OPA policy engine.

   (3) Initial capacity in bytes of the local cache. The cache is used so that the plugin does not have to query the OPA policy engine for every request.

   (4) Maximum capacity in bytes of the local cache.

   (5) Time in milliseconds that the local cache is refreshed by reloading from the OPA policy engine.

   (6) A list of user principals treated as super users, so that they are always allowed without querying the Open Policy Agent policy.

   Refer to the Open Policy Agent website for information on authentication and authorization options.

5. Verify the configured permissions by accessing Kafka brokers using clients that have and do not have the correct authorization.

4.13. LOGGING

Kafka brokers use Log4j as their logging infrastructure. By default, the logging configuration is read from the **log4j.properties** configuration file, which should be placed either in the **/opt/kafka/config/** directory or on the classpath. The location and name of the configuration file can be changed using the Java property **log4j.configuration**, which can be passed to Kafka by using the **KAFKA_LOG4J_OPTS** environment variable:

```
su - kafka
export KAFKA_LOG4J_OPTS="-Dlog4j.configuration=file:/my/path/to/log4j.config";
/opt/kafka/bin/kafka-server-start.sh /opt/kafka/config/server.properties
```

For more information about Log4j configurations, see the Log4j manual.

4.13.1. Dynamically change logging levels for Kafka broker loggers

Kafka broker logging is provided by multiple *broker loggers* in each broker. You can dynamically change the logging level for broker loggers without having to restart the broker. Increasing the level of detail returned in logs—by changing from **INFO** to **DEBUG**, for example—is useful for investigating performance issues in a Kafka cluster.

Broker loggers can also be dynamically reset to their default logging levels.

Prerequisites

- AMQ Streams is installed on the host
- ZooKeeper and Kafka are running

Procedure

1. Switch to the **kafka** user:

   ```
   su - kafka
   ```

2. List all the broker loggers for a broker by using the **kafka-configs.sh** tool:

   ```
   /opt/kafka/bin/kafka-configs.sh --bootstrap-server BOOTSTRAP-ADDRESS --describe --
   entity-type broker-loggers --entity-name BROKER-ID
   ```

   For example, for broker **0**:

   ```
   /opt/kafka/bin/kafka-configs.sh --bootstrap-server localhost:9092 --describe --entity-type
   broker-loggers --entity-name 0
   ```

   This returns the logging level for each logger: **TRACE**, **DEBUG**, **INFO**, **WARN**, **ERROR**, or **FATAL**. For example:

   ```
   #...
   kafka.controller.ControllerChannelManager=INFO sensitive=false synonyms={}
   kafka.log.TimeIndex=INFO sensitive=false synonyms={}
   ```

3. Change the logging level for one or more broker loggers. Use the **--alter** and **--add-config** options and specify each logger and its level as a comma-separated list in double quotes.

```
/opt/kafka/bin/kafka-configs.sh --bootstrap-server BOOTSTRAP-ADDRESS --alter --add-config "LOGGER-ONE=NEW-LEVEL,LOGGER-TWO=NEW-LEVEL" --entity-type broker-loggers --entity-name BROKER-ID
```

For example, for broker **0**:

```
/opt/kafka/bin/kafka-configs.sh --bootstrap-server localhost:9092 --alter --add-config "kafka.controller.ControllerChannelManager=WARN,kafka.log.TimeIndex=WARN" --entity-type broker-loggers --entity-name 0
```

If successful this returns:

```
Completed updating config for broker: 0.
```

Resetting a broker logger

You can reset one or more broker loggers to their default logging levels by using the **kafka-configs.sh** tool. Use the **--alter** and **--delete-config** options and specify each broker logger as a comma-separated list in double quotes:

```
/opt/kafka/bin/kafka-configs.sh --bootstrap-server localhost:9092 --alter --delete-config "LOGGER-ONE,LOGGER-TWO" --entity-type broker-loggers --entity-name BROKER-ID
```

Additional resources

- Updating Broker Configs in the Apache Kafka documentation.

CHAPTER 5. TOPICS

Messages in Kafka are always sent to or received from a topic. This chapter describes how to configure and manage Kafka topics.

5.1. PARTITIONS AND REPLICAS

Messages in Kafka are always sent to or received from a topic. A topic is always split into one or more partitions. Partitions act as shards. That means that every message sent by a producer is always written only into a single partition. Thanks to the sharding of messages into different partitions, topics are easy to scale horizontally.

Each partition can have one or more replicas, which will be stored on different brokers in the cluster. When creating a topic you can configure the number of replicas using the *replication factor*. *Replication factor* defines the number of copies which will be held within the cluster. One of the replicas for given partition will be elected as a leader. The leader replica will be used by the producers to send new messages and by the consumers to consume messages. The other replicas will be follower replicas. The followers replicate the leader.

If the leader fails, one of the followers will automatically become the new leader. Each server acts as a leader for some of its partitions and a follower for others so the load is well balanced within the cluster.

NOTE

The replication factor determines the number of replicas including the leader and the followers. For example, if you set the replication factor to **3**, then there will one leader and two follower replicas.

5.2. MESSAGE RETENTION

The message retention policy defines how long the messages will be stored on the Kafka brokers. It can be defined based on time, partition size or both.

For example, you can define that the messages should be kept:

- For 7 days
- Until the parition has 1GB of messages. Once the limit is reached, the oldest messages will be removed.
- For 7 days or until the 1GB limit has been reached. Whatever limit comes first will be used.

WARNING

Kafka brokers store messages in log segments. The messages which are past their retention policy will be deleted only when a new log segment is created. New log segments are created when the previous log segment exceeds the configured log segment size. Additionally, users can request new segments to be created periodically.

Additionally, Kafka brokers support a compacting policy.

For a topic with the compacted policy, the broker will always keep only the last message for each key. The older messages with the same key will be removed from the partition. Because compacting is a periodically executed action, it does not happen immediately when the new message with the same key are sent to the partition. Instead it might take some time until the older messages are removed.

For more information about the message retention configuration options, see Section 5.5, "Topic configuration".

5.3. TOPIC AUTO-CREATION

When a producer or consumer tries to send messages to or receive messages from a topic that does not exist, Kafka will, by default, automatically create that topic. This behavior is controlled by the **auto.create.topics.enable** configuration property which is set to **true** by default.

To disable it, set **auto.create.topics.enable** to **false** in the Kafka broker configuration file:

```
auto.create.topics.enable=false
```

5.4. TOPIC DELETION

Kafka offers the possibility to disable deletion of topics. This is configured through the **delete.topic.enable** property, which is set to **true** by default (that is, deleting topics is possible). When this property is set to **false** it will be not possible to delete topics and all attempts to delete topic will return success but the topic will not be deleted.

```
delete.topic.enable=false
```

5.5. TOPIC CONFIGURATION

Auto-created topics will use the default topic configuration which can be specified in the broker properties file. However, when creating topics manually, their configuration can be specified at creation time. It is also possible to change a topic's configuration after it has been created. The main topic configuration options for manually created topics are:

cleanup.policy

Configures the retention policy to **delete** or **compact**. The **delete** policy will delete old records. The **compact** policy will enable log compaction. The default value is **delete**. For more information about log compaction, see Kafka website.

compression.type

Specifies the compression which is used for stored messages. Valid values are **gzip**, **snappy**, **lz4**, **uncompressed** (no compression) and **producer** (retain the compression codec used by the producer). The default value is **producer**.

max.message.bytes

The maximum size of a batch of messages allowed by the Kafka broker, in bytes. The default value is **1000012**.

min.insync.replicas

The minimum number of replicas which must be in sync for a write to be considered successful. The default value is **1**.

retention.ms

Maximum number of milliseconds for which log segments will be retained. Log segments older than this value will be deleted. The default value is **604800000** (7 days).

retention.bytes

The maximum number of bytes a partition will retain. Once the partition size grows over this limit, the oldest log segments will be deleted. Value of **-1** indicates no limit. The default value is **-1**.

segment.bytes

The maximum file size of a single commit log segment file in bytes. When the segment reaches its size, a new segment will be started. The default value is **1073741824** bytes (1 gibibyte).

For list of all supported topic configuration options, see Appendix B, *Topic configuration parameters*.

The defaults for auto-created topics can be specified in the Kafka broker configuration using similar options:

log.cleanup.policy

See **cleanup.policy** above.

compression.type

See **compression.type** above.

message.max.bytes

See **max.message.bytes** above.

min.insync.replicas

See **min.insync.replicas** above.

log.retention.ms

See **retention.ms** above.

log.retention.bytes

See **retention.bytes** above.

log.segment.bytes

See **segment.bytes** above.

default.replication.factor

Default replication factor for automatically created topics. Default value is **1**.

num.partitions

Default number of partitions for automatically created topics. Default value is **1**.

For list of all supported Kafka broker configuration options, see Appendix A, *Broker configuration parameters*.

5.6. INTERNAL TOPICS

Internal topics are created and used internally by the Kafka brokers and clients. Kafka has several internal topics. These are used to store consumer offsets (**__consumer_offsets**) or transaction state (**__transaction_state**). These topics can be configured using dedicated Kafka broker configuration options starting with prefix **offsets.topic.** and **transaction.state.log.**. The most important configuration options are:

offsets.topic.replication.factor

Number of replicas for **__consumer_offsets** topic. The default value is **3**.

offsets.topic.num.partitions

Number of partitions for **__consumer_offsets** topic. The default value is **50**.

transaction.state.log.replication.factor

Number of replicas for **__transaction_state** topic. The default value is **3**.

transaction.state.log.num.partitions

Number of partitions for **__transaction_state** topic. The default value is **50**.

transaction.state.log.min.isr

Minimum number of replicas that must acknowledge a write to **__transaction_state** topic to be considered successful. If this minimum cannot be met, then the producer will fail with an exception. The default value is **2**.

5.7. CREATING A TOPIC

The **kafka-topics.sh** tool can be used to manage topics. **kafka-topics.sh** is part of the AMQ Streams distribution and can be found in the **bin** directory.

Prerequisites

- AMQ Streams cluster is installed and running

Creating a topic

1. Create a topic using the **kafka-topics.sh** utility and specify the following:
   - Host and port of the Kafka broker in the **--bootstrap-server** option.
   - The new topic to be created in the **--create** option.
   - Topic name in the **--topic** option.
   - The number of partitions in the **--partitions** option.
   - Topic replication factor in the **--replication-factor** option.
     You can also override some of the default topic configuration options using the option **--config**. This option can be used multiple times to override different options.

     ```
     bin/kafka-topics.sh --bootstrap-server <BrokerAddress> --create --topic <TopicName> --partitions <NumberOfPartitions> --replication-factor <ReplicationFactor> --config <Option1>=<Value1> --config <Option2>=<Value2>
     ```

     Example of the command to create a topic named mytopic

     ```
     bin/kafka-topics.sh --bootstrap-server localhost:9092 --create --topic mytopic --partitions 50 --replication-factor 3 --config cleanup.policy=compact --config min.insync.replicas=2
     ```

2. Verify that the topic exists using **kafka-topics.sh**.

   ```
   bin/kafka-topics.sh --bootstrap-server <BrokerAddress> --describe --topic <TopicName>
   ```

   Example of the command to describe a topic named mytopic

   ```
   bin/kafka-topics.sh --bootstrap-server localhost:9092 --describe --topic mytopic
   ```

Additional resources

- For more information about topic configuration, see Section 5.5, "Topic configuration".
- For list of all supported topic configuration options, see Appendix B, *Topic configuration parameters*.

5.8. LISTING AND DESCRIBING TOPICS

The **kafka-topics.sh** tool can be used to list and describe topics. **kafka-topics.sh** is part of the AMQ Streams distribution and can be found in the **bin** directory.

Prerequisites

- AMQ Streams cluster is installed and running
- Topic **mytopic** exists

Describing a topic

1. Describe a topic using the **kafka-topics.sh** utility and specify the following:
   - Host and port of the Kafka broker in the **--bootstrap-server** option.
   - Use the **--describe** option to specify that you want to describe a topic.
   - Topic name must be specified in the **--topic** option.
   - When the **--topic** option is omitted, it will describe all available topics.

     ```
     bin/kafka-topics.sh --bootstrap-server <BrokerAddress> --describe --topic <TopicName>
     ```

     Example of the command to describe a topic named mytopic

     ```
     bin/kafka-topics.sh --bootstrap-server localhost:9092 --describe --topic mytopic
     ```

     The describe command will list all partitions and replicas which belong to this topic. It will also list all topic configuration options.

Additional resources

- For more information about topic configuration, see Section 5.5, "Topic configuration".
- For more information about creating topics, see Section 5.7, "Creating a topic".

5.9. MODIFYING A TOPIC CONFIGURATION

The **kafka-configs.sh** tool can be used to modify topic configurations. **kafka-configs.sh** is part of the AMQ Streams distribution and can be found in the **bin** directory.

Prerequisites

- AMQ Streams cluster is installed and running

- Topic **mytopic** exists

Modify topic configuration

1. Use the **kafka-configs.sh** tool to get the current configuration.
   - Specify the host and port of the Kafka broker in the **--bootstrap-server** option.
   - Set the **--entity-type** as **topic** and **--entity-name** to the name of your topic.
   - Use **--describe** option to get the current configuration.

     ```
     bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --entity-type topics --entity-name <TopicName> --describe
     ```

     Example of the command to get configuration of a topic named mytopic

     ```
     bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type topics --entity-name mytopic --describe
     ```

2. Use the **kafka-configs.sh** tool to change the configuration.
   - Specify the host and port of the Kafka broker in the **--bootstrap-server** option.
   - Set the **--entity-type** as **topic** and **--entity-name** to the name of your topic.
   - Use **--alter** option to modify the current configuration.
   - Specify the options you want to add or change in the option **--add-config**.

     ```
     bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --entity-type topics --entity-name <TopicName> --alter --add-config <Option>=<Value>
     ```

     Example of the command to change configuration of a topic named mytopic

     ```
     bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type topics --entity-name mytopic --alter --add-config min.insync.replicas=1
     ```

3. Use the **kafka-configs.sh** tool to delete an existing configuration option.
   - Specify the host and port of the Kafka broker in the **--bootstrap-server** option.
   - Set the **--entity-type** as **topic** and **--entity-name** to the name of your topic.
   - Use **--delete-config** option to remove existing configuration option.
   - Specify the options you want to remove in the option **--remove-config**.

     ```
     bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --entity-type topics --entity-name <TopicName> --alter --delete-config <Option>
     ```

     Example of the command to change configuration of a topic named mytopic

```
bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type topics --entity-name
mytopic --alter --delete-config min.insync.replicas
```

Additional resources

- For more information about topic configuration, see Section 5.5, "Topic configuration".
- For more information about creating topics, see Section 5.7, "Creating a topic".
- For list of all supported topic configuration options, see Appendix B, *Topic configuration parameters*.

5.10. DELETING A TOPIC

The **kafka-topics.sh** tool can be used to manage topics. **kafka-topics.sh** is part of the AMQ Streams distribution and can be found in the **bin** directory.

Prerequisites

- AMQ Streams cluster is installed and running
- Topic **mytopic** exists

Deleting a topic

1. Delete a topic using the **kafka-topics.sh** utility.
   - Host and port of the Kafka broker in the **--bootstrap-server** option.
   - Use the **--delete** option to specify that an existing topic should be deleted.
   - Topic name must be specified in the **--topic** option.

     ```
     bin/kafka-topics.sh --bootstrap-server <BrokerAddress> --delete --topic <TopicName>
     ```

     Example of the command to create a topic named mytopic

     ```
     bin/kafka-topics.sh --bootstrap-server localhost:9092 --delete --topic mytopic
     ```

2. Verify that the topic was deleted using **kafka-topics.sh**.

   ```
   bin/kafka-topics.sh --bootstrap-server <BrokerAddress> --list
   ```

   Example of the command to list all topics

   ```
   bin/kafka-topics.sh --bootstrap-server localhost:9092 --list
   ```

Additional resources

- For more information about creating topics, see Section 5.7, "Creating a topic".

CHAPTER 6. TUNING CLIENT CONFIGURATION

Use configuration properties to optimize the performance of Kafka producers and consumers.

A minimum set of configuration properties is required, but you can add or adjust properties to change how producers and consumers interact with Kafka. For example, for producers you can tune latency and throughput of messages so that clients can respond to data in real time. Or you can change the configuration to provide stronger message durability guarantees.

You might start by analyzing client metrics to gauge where to make your initial configurations, then make incremental changes and further comparisons until you have the configuration you need.

6.1. KAFKA PRODUCER CONFIGURATION TUNING

Use a basic producer configuration with optional properties that are tailored to specific use cases.

Adjusting your configuration to maximize throughput might increase latency or vice versa. You will need to experiment and tune your producer configuration to get the balance you need.

6.1.1. Basic producer configuration

Connection and serializer properties are required for every producer. Generally, it is good practice to add a client id for tracking, and use compression on the producer to reduce batch sizes in requests.

In a basic producer configuration:

- The order of messages in a partition is not guaranteed.
- The acknowledgment of messages reaching the broker does not guarantee durability.

```
# ...
bootstrap.servers=localhost:9092 1
key.serializer=org.apache.kafka.common.serialization.StringSerializer 2
value.serializer=org.apache.kafka.common.serialization.StringSerializer 3
client.id=my-client 4
compression.type=gzip 5
# ...
```

1. (Required) Tells the producer to connect to a Kafka cluster using a *host:port* bootstrap server address for a Kafka broker. The producer uses the address to discover and connect to all brokers in the cluster. Use a comma-separated list to specify two or three addresses in case a server is down, but it's not necessary to provide a list of all the brokers in the cluster.
2. (Required) Serializer to transform the key of each message to bytes prior to them being sent to a broker.
3. (Required) Serializer to transform the value of each message to bytes prior to them being sent to a broker.
4. (Optional) The logical name for the client, which is used in logs and metrics to identify the source of a request.
5.

(Optional) The codec for compressing messages, which are sent and might be stored in compressed format and then decompressed when reaching a consumer. Compression is useful for

6.1.2. Data durability

You can apply greater data durability, to minimize the likelihood that messages are lost, using message delivery acknowledgments.

```
# ...
acks=all (1)
# ...
```

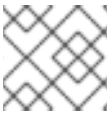
(1) Specifying **acks=all** forces a partition leader to replicate messages to a certain number of followers before acknowledging that the message request was successfully received. Because of the additional checks, **acks=all** increases the latency between the producer sending a message and receiving acknowledgment.

The number of brokers which need to have appended the messages to their logs before the acknowledgment is sent to the producer is determined by the topic's **min.insync.replicas** configuration. A typical starting point is to have a topic replication factor of 3, with two in-sync replicas on other brokers. In this configuration, the producer can continue unaffected if a single broker is unavailable. If a second broker becomes unavailable, the producer won't receive acknowledgments and won't be able to produce more messages.

Topic configuration to support acks=all

```
# ...
min.insync.replicas=2 (1)
# ...
```

(1) Use **2** in-sync replicas. The default is **1**.



NOTE

If the system fails, there is a risk of unsent data in the buffer being lost.

6.1.3. Ordered delivery

Idempotent producers avoid duplicates as messages are delivered exactly once. IDs and sequence numbers are assigned to messages to ensure the order of delivery, even in the event of failure. If you are using **acks=all** for data consistency, enabling idempotency makes sense for ordered delivery.

Ordered delivery with idempotency

```
# ...
enable.idempotence=true (1)
max.in.flight.requests.per.connection=5 (2)
acks=all (3)
retries=2147483647 (4)
# ...
```

1. Set to **true** to enable the idempotent producer.
2. With idempotent delivery the number of in-flight requests may be greater than 1 while still providing the message ordering guarantee. The default is 5 in-flight requests.
3. Set **acks** to **all**.
4. Set the number of attempts to resend a failed message request.

If you are not using **acks=all** and idempotency because of the performance cost, set the number of in-flight (unacknowledged) requests to 1 to preserve ordering. Otherwise, a situation is possible where *Message-A* fails only to succeed after *Message-B* was already written to the broker.

Ordered delivery without idempotency

```
# ...
enable.idempotence=false (1)
max.in.flight.requests.per.connection=1 (2)
retries=2147483647
# ...
```

1. Set to **false** to disable the idempotent producer.
2. Set the number of in-flight requests to exactly **1**.

6.1.4. Reliability guarantees

Idempotence is useful for exactly once writes to a single partition. Transactions, when used with idempotence, allow exactly once writes across multiple partitions.

Transactions guarantee that messages using the same transactional ID are produced once, and either *all* are successfully written to the respective logs or *none* of them are.

```
# ...
enable.idempotence=true
max.in.flight.requests.per.connection=5
acks=all
retries=2147483647
transactional.id=UNIQUE-ID (1)
transaction.timeout.ms=900000 (2)
# ...
```

1. Specify a unique transactional ID.
2. Set the maximum allowed time for transactions in milliseconds before a timeout error is returned. The default is **900000** or 15 minutes.

The choice of **transactional.id** is important in order that the transactional guarantee is maintained. Each transactional id should be used for a unique set of topic partitions. For example, this can be achieved using an external mapping of topic partition names to transactional ids, or by computing the transactional id from the topic partition names using a function that avoids collisions.

6.1.5. Optimizing throughput and latency

Usually, the requirement of a system is to satisfy a particular throughput target for a proportion of messages within a given latency. For example, targeting 500,000 messages per second with 95% of messages being acknowledged within 2 seconds.

It's likely that the messaging semantics (message ordering and durability) of your producer are defined by the requirements for your application. For instance, it's possible that you don't have the option of using **acks=0** or **acks=1** without breaking some important property or guarantee provided by your application.

Broker restarts have a significant impact on high percentile statistics. For example, over a long period the 99th percentile latency is dominated by behavior around broker restarts. This is worth considering when designing benchmarks or comparing performance numbers from benchmarking with performance numbers seen in production.

Depending on your objective, Kafka offers a number of configuration parameters and techniques for tuning producer performance for throughput and latency.

Message batching (linger.ms and batch.size)

Message batching delays sending messages in the hope that more messages destined for the same broker will be sent, allowing them to be batched into a single produce request. Batching is a compromise between higher latency in return for higher throughput. Time-based batching is configured using **linger.ms**, and size-based batching is configured using **batch.size**.

Compression (compression.type)

Message compression adds latency in the producer (CPU time spent compressing the messages), but makes requests (and potentially disk writes) smaller, which can increase throughput. Whether compression is worthwhile, and the best compression to use, will depend on the messages being sent. Compression happens on the thread which calls **KafkaProducer.send()**, so if the latency of this method matters for your application you should consider using more threads.

Pipelining (max.in.flight.requests.per.connection)

Pipelining means sending more requests before the response to a previous request has been received. In general more pipelining means better throughput, up to a threshold at which other effects, such as worse batching, start to counteract the effect on throughput.

Lowering latency

When your application calls **KafkaProducer.send()** the messages are:

- Processed by any interceptors
- Serialized
- Assigned to a partition
- Compressed
- Added to a batch of messages in a per-partition queue

At which point the **send()** method returns. So the time **send()** is blocked is determined by:

- The time spent in the interceptors, serializers and partitioner
- The compression algorithm used
- The time spent waiting for a buffer to use for compression

Batches will remain in the queue until one of the following occurs:

- The batch is full (according to **batch.size**)
- The delay introduced by **linger.ms** has passed
- The sender is about to send message batches for other partitions to the same broker, and it is possible to add this batch too
- The producer is being flushed or closed

Look at the configuration for batching and buffering to mitigate the impact of **send()** blocking on latency.

```
# ...
linger.ms=100 1
batch.size=16384 2
buffer.memory=33554432 3
# ...
```

1. The **linger** property adds a delay in milliseconds so that larger batches of messages are accumulated and sent in a request. The default is **0'.**
2. If a maximum **batch.size** in bytes is used, a request is sent when the maximum is reached, or messages have been queued for longer than **linger.ms** (whichever comes sooner). Adding the delay allows batches to accumulate messages up to the batch size.
3. The buffer size must be at least as big as the batch size, and be able to accommodate buffering, compression and in-flight requests.

Increasing throughput

Improve throughput of your message requests by adjusting the maximum time to wait before a message is delivered and completes a send request.

You can also direct messages to a specified partition by writing a custom partitioner to replace the default.

```
# ...
delivery.timeout.ms=120000 1
partitioner.class=my-custom-partitioner 2

# ...
```

1. The maximum time in milliseconds to wait for a complete send request. You can set the value to **MAX_LONG** to delegate to Kafka an indefinite number of retries. The default is **120000** or 2 minutes.
2. Specify the class name of the custom partitioner.

6.2. KAFKA CONSUMER CONFIGURATION TUNING

Use a basic consumer configuration with optional properties that are tailored to specific use cases.

When tuning your consumers your primary concern will be ensuring that they cope efficiently with the amount of data ingested. As with the producer tuning, be prepared to make incremental changes until the consumers operate as expected.

6.2.1. Basic consumer configuration

Connection and deserializer properties are required for every consumer. Generally, it is good practice to add a client id for tracking.

In a consumer configuration, irrespective of any subsequent configuration:

- The consumer fetches from a given offset and consumes the messages in order, unless the offset is changed to skip or re-read messages.
- The broker does not know if the consumer processed the responses, even when committing offsets to Kafka, because the offsets might be sent to a different broker in the cluster.

```
# ...
bootstrap.servers=localhost:9092 1
key.deserializer=org.apache.kafka.common.serialization.StringDeserializer 2
value.deserializer=org.apache.kafka.common.serialization.StringDeserializer 3
client.id=my-client 4
group.id=my-group-id 5
# ...
```

1. (Required) Tells the consumer to connect to a Kafka cluster using a *host:port* bootstrap server address for a Kafka broker. The consumer uses the address to discover and connect to all brokers in the cluster. Use a comma-separated list to specify two or three addresses in case a server is down, but it is not necessary to provide a list of all the brokers in the cluster. If you are using a loadbalancer service to expose the Kafka cluster, you only need the address for the service because the availability is handled by the loadbalancer.
2. (Required) Deserializer to transform the bytes fetched from the Kafka broker into message keys.
3. (Required) Deserializer to transform the bytes fetched from the Kafka broker into message values.
4. (Optional) The logical name for the client, which is used in logs and metrics to identify the source of a request. The id can also be used to throttle consumers based on processing time quotas.
5. (Conditional) A group id is *required* for a consumer to be able to join a consumer group.

Consumer groups are used to share a typically large data stream generated by multiple producers from a given topic. Consumers are grouped using a **group.id**, allowing messages to be spread across the members.

6.2.2. Scaling data consumption using consumer groups

Consumer groups share a typically large data stream generated by one or multiple producers from a given topic. Consumers with the same **group.id** property are in the same group. One of the consumers in the group is elected leader and decides how the partitions are assigned to the consumers in the group. Each partition can only be assigned to a single consumer.

If you do not already have as many consumers as partitions, you can scale data consumption by adding more consumer instances with the same **group.id**. Adding more consumers to a group than there are

partitions will not help throughput, but it does mean that there are consumers on standby should one stop functioning. If you can meet throughput goals with fewer consumers, you save on resources.

Consumers within the same consumer group send offset commits and heartbeats to the same broker. So the greater the number of consumers in the group, the higher the request load on the broker.

```
# ...
group.id=my-group-id (1)
# ...
```

(1) Add a consumer to a consumer group using a group id.

6.2.3. Message ordering guarantees

Kafka brokers receive fetch requests from consumers that ask the broker to send messages from a list of topics, partitions and offset positions.

A consumer observes messages in a single partition in the same order that they were committed to the broker, which means that Kafka **only** provides ordering guarantees for messages in a single partition. Conversely, if a consumer is consuming messages from multiple partitions, the order of messages in different partitions as observed by the consumer does not necessarily reflect the order in which they were sent.

If you want a strict ordering of messages from one topic, use one partition per consumer.

6.2.4. Optimizing throughput and latency

Control the number of messages returned when your client application calls **KafkaConsumer.poll()**.

Use the **fetch.max.wait.ms** and **fetch.min.bytes** properties to increase the minimum amount of data fetched by the consumer from the Kafka broker. Time-based batching is configured using **fetch.max.wait.ms**, and size-based batching is configured using **fetch.min.bytes**.

If CPU utilization in the consumer or broker is high, it might be because there are too many requests from the consumer. You can adjust **fetch.max.wait.ms** and **fetch.min.bytes** properties higher so that there are fewer requests and messages are delivered in bigger batches. By adjusting higher, throughput is improved with some cost to latency. You can also adjust higher if the amount of data being produced is low.

For example, if you set **fetch.max.wait.ms** to 500ms and **fetch.min.bytes** to 16384 bytes, when Kafka receives a fetch request from the consumer it will respond when the first of either threshold is reached.

Conversely, you can adjust the **fetch.max.wait.ms** and **fetch.min.bytes** properties lower to improve end-to-end latency.

```
# ...
fetch.max.wait.ms=500 (1)
fetch.min.bytes=16384 (2)
# ...
```

(1) The maximum time in milliseconds the broker will wait before completing fetch requests. The default is **500** milliseconds.

(2) If a minimum batch size in bytes is used, a request is sent when the minimum is reached, or

messages have been queued for longer than **fetch.max.wait.ms** (whichever comes sooner). Adding the delay allows batches to accumulate messages up to the batch size.

Lowering latency by increasing the fetch request size

Use the **fetch.max.bytes** and **max.partition.fetch.bytes** properties to increase the maximum amount of data fetched by the consumer from the Kafka broker.

The **fetch.max.bytes** property sets a maximum limit in bytes on the amount of data fetched from the broker at one time.

The **max.partition.fetch.bytes** sets a maximum limit in bytes on how much data is returned for each partition, which must always be larger than the number of bytes set in the broker or topic configuration for **max.message.bytes**.

The maximum amount of memory a client can consume is calculated approximately as:

```
NUMBER-OF-BROKERS * fetch.max.bytes and NUMBER-OF-PARTITIONS *
max.partition.fetch.bytes
```

If memory usage can accommodate it, you can increase the values of these two properties. By allowing more data in each request, latency is improved as there are fewer fetch requests.

```
# ...
fetch.max.bytes=52428800 (1)
max.partition.fetch.bytes=1048576 (2)
# ...
```

1. The maximum amount of data in bytes returned for a fetch request.
2. The maximum amount of data in bytes returned for each partition.

6.2.5. Avoiding data loss or duplication when committing offsets

The Kafka *auto-commit mechanism* allows a consumer to commit the offsets of messages automatically. If enabled, the consumer will commit offsets received from polling the broker at 5000ms intervals.

The auto-commit mechanism is convenient, but it introduces a risk of data loss and duplication. If a consumer has fetched and transformed a number of messages, but the system crashes with processed messages in the consumer buffer when performing an auto-commit, that data is lost. If the system crashes after processing the messages, but before performing the auto-commit, the data is duplicated on another consumer instance after rebalancing.

Auto-committing can avoid data loss only when all messages are processed before the next poll to the broker, or the consumer closes.

To minimize the likelihood of data loss or duplication, you can set **enable.auto.commit** to **false** and develop your client application to have more control over committing offsets. Or you can use **auto.commit.interval.ms** to decrease the intervals between commits.

```
# ...
enable.auto.commit=false (1)
# ...
```

1 Auto commit is set to false to provide more control over committing offsets.

By setting to **enable.auto.commit** to **false**, you can commit offsets after **all** processing has been performed and the message has been consumed. For example, you can set up your application to call the Kafka **commitSync** and **commitAsync** commit APIs.

The **commitSync** API commits the offsets in a message batch returned from polling. You call the API when you are finished processing all the messages in the batch. If you use the **commitSync** API, the application will not poll for new messages until the last offset in the batch is committed. If this negatively affects throughput, you can commit less frequently, or you can use the **commitAsync** API. The **commitAsync** API does not wait for the broker to respond to a commit request, but risks creating more duplicates when rebalancing. A common approach is to combine both commit APIs in an application, with the **commitSync** API used just before shutting the consumer down or rebalancing to make sure the final commit is successful.

6.2.5.1. Controlling transactional messages

Consider using transactional ids and enabling idempotence (**enable.idempotence=true**) on the producer side to guarantee exactly-once delivery. On the consumer side, you can then use the **isolation.level** property to control how transactional messages are read by the consumer.

The **isolation.level** property has two valid values:

- **read_committed**
- **read_uncommitted** (default)

Use **read_committed** to ensure that only transactional messages that have been committed are read by the consumer. However, this will cause an increase in end-to-end latency, because the consumer will not be able to return a message until the brokers have written the transaction markers that record the result of the transaction (*committed* or *aborted*).

```
# ...
enable.auto.commit=false
isolation.level=read_committed 1
# ...
```

1 Set to **read_committed** so that only committed messages are read by the consumer.

6.2.6. Recovering from failure to avoid data loss

Use the **session.timeout.ms** and **heartbeat.interval.ms** properties to configure the time taken to check and recover from consumer failure within a consumer group.

The **session.timeout.ms** property specifies the maximum amount of time in milliseconds a consumer within a consumer group can be out of contact with a broker before being considered inactive and a *rebalancing* is triggered between the active consumers in the group. When the group rebalances, the partitions are reassigned to the members of the group.

The **heartbeat.interval.ms** property specifies the interval in milliseconds between *heartbeat* checks to the consumer group coordinator to indicate that the consumer is active and connected. The heartbeat interval must be lower, usually by a third, than the session timeout interval.

If you set the **session.timeout.ms** property lower, failing consumers are detected earlier, and rebalancing can take place quicker. However, take care not to set the timeout so low that the broker fails to receive a heartbeat in time and triggers an unnecessary rebalance.

Decreasing the heartbeat interval reduces the chance of accidental rebalancing, but more frequent heartbeats increases the overhead on broker resources.

6.2.7. Managing offset policy

Use the **auto.offset.reset** property to control how a consumer behaves when no offsets have been committed, or a committed offset is no longer valid or deleted.

Suppose you deploy a consumer application for the first time, and it reads messages from an existing topic. Because this is the first time the **group.id** is used, the **__consumer_offsets** topic does not contain any offset information for this application. The new application can start processing all existing messages from the start of the log or only new messages. The default reset value is **latest**, which starts at the end of the partition, and consequently means some messages are missed. To avoid data loss, but increase the amount of processing, set **auto.offset.reset** to **earliest** to start at the beginning of the partition.

Also consider using the **earliest** option to avoid messages being lost when the offsets retention period (**offsets.retention.minutes**) configured for a broker has ended. If a consumer group or standalone consumer is inactive and commits no offsets during the retention period, previously committed offsets are deleted from **__consumer_offsets**.

```
# ...
heartbeat.interval.ms=3000 1
session.timeout.ms=10000 2
auto.offset.reset=earliest 3
# ...
```

1. Adjust the heartbeat interval lower according to anticipated rebalances.
2. If no heartbeats are received by the Kafka broker before the timeout duration expires, the consumer is removed from the consumer group and a rebalance is initiated. If the broker configuration has a **group.min.session.timeout.ms** and **group.max.session.timeout.ms**, the session timeout value must be within that range.
3. Set to **earliest** to return to the start of a partition and avoid data loss if offsets were not committed.

If the amount of data returned in a single fetch request is large, a timeout might occur before the consumer has processed it. In this case, you can lower **max.partition.fetch.bytes** or increase **session.timeout.ms**.

6.2.8. Minimizing the impact of rebalances

The rebalancing of a partition between active consumers in a group is the time it takes for:

- Consumers to commit their offsets
- The new consumer group to be formed
- The group leader to assign partitions to group members

- The consumers in the group to receive their assignments and start fetching

Clearly, the process increases the downtime of a service, particularly when it happens repeatedly during a rolling restart of a consumer group cluster.

In this situation, you can use the concept of *static membership* to reduce the number of rebalances. Rebalancing assigns topic partitions evenly among consumer group members. Static membership uses persistence so that a consumer instance is recognized during a restart after a session timeout.

The consumer group coordinator can identify a new consumer instance using a unique id that is specified using the **group.instance.id** property. During a restart, the consumer is assigned a new member id, but as a static member it continues with the same instance id, and the same assignment of topic partitions is made.

If the consumer application does not make a call to poll at least every **max.poll.interval.ms** milliseconds, the consumer is considered to be failed, causing a rebalance. If the application cannot process all the records returned from poll in time, you can avoid a rebalance by using the **max.poll.interval.ms** property to specify the interval in milliseconds between polls for new messages from a consumer. Or you can use the **max.poll.records** property to set a maximum limit on the number of records returned from the consumer buffer, allowing your application to process fewer records within the **max.poll.interval.ms** limit.

```
# ...
group.instance.id=UNIQUE-ID 1
max.poll.interval.ms=300000 2
max.poll.records=500 3
# ...
```

1. The unique instance id ensures that a new consumer instance receives the same assignment of topic partitions.
2. Set the interval to check the consumer is continuing to process messages.
3. Sets the number of processed records returned from the consumer.

CHAPTER 7. SCALING CLUSTERS

7.1. SCALING KAFKA CLUSTERS

7.1.1. Adding brokers to a cluster

The primary way of increasing throughput for a topic is to increase the number of partitions for that topic. That works because the partitions allow the load for that topic to be shared between the brokers in the cluster. When the brokers are all constrained by some resource (typically I/O), then using more partitions will not yield an increase in throughput. Instead, you must add brokers to the cluster.

When you add an extra broker to the cluster, AMQ Streams does not assign any partitions to it automatically. You have to decide which partitions to move from the existing brokers to the new broker.

Once the partitions have been redistributed between all brokers, each broker should have a lower resource utilization.

7.1.2. Removing brokers from the cluster

Before you remove a broker from a cluster, you must ensure that it is not assigned to any partitions. You should decide which remaining brokers will be responsible for each of the partitions on the broker being decommissioned. Once the broker has no assigned partitions, you can stop it.

7.2. REASSIGNMENT OF PARTITIONS

The **kafka-reassign-partitions.sh** utility is used to reassign partitions to different brokers.

It has three different modes:

--generate

Takes a set of topics and brokers and generates a *reassignment JSON file* which will result in the partitions of those topics being assigned to those brokers. It is an easy way to generate a *reassignment JSON file*, but it operates on whole topics, so its use is not always appropriate.

--execute

Takes a *reassignment JSON file* and applies it to the partitions and brokers in the cluster. Brokers which are gaining partitions will become followers of the partition leader. For a given partition, once the new broker has caught up and joined the ISR the old broker will stop being a follower and will delete its replica.

--verify

Using the same *reassignment JSON file* as the **--execute** step, **--verify** checks whether all of the partitions in the file have been moved to their intended brokers. If the reassignment is complete it will also remove any throttles which are in effect. Unless removed, throttles will continue to affect the cluster even after the reassignment has finished.

It is only possible to have one reassignment running in the cluster at any given time, and it is not possible to cancel a running reassignment. If you need to cancel a reassignment you have to wait for it to complete and then perform another reassignment to revert the effects of the first one. The **kafka-reassign-partitions.sh** will print the reassignment JSON for this reversion as part of its output. Very large reassignments should be broken down into a number of smaller reassignments in case there is a need to stop in-progress reassignment.

7.2.1. Reassignment JSON file

The *reassignment JSON file* has a specific structure:

```
{
  "version": 1,
  "partitions": [
    <PartitionObjects>
  ]
}
```

Where *<PartitionObjects>* is a comma-separated list of objects like:

```
{
  "topic": <TopicName>,
  "partition": <Partition>,
  "replicas": [ <AssignedBrokerIds> ],
  "log_dirs": [<LogDirs>]
}
```

The **"log_dirs"** property is optional and is used to move the partition to a specific log directory.

The following is an example reassignment JSON file that assigns topic **topic-a**, partition **4** to brokers **2**, **4** and **7**, and topic **topic-b** partition **2** to brokers **1**, **5** and **7**:

```
{
  "version": 1,
  "partitions": [
    {
      "topic": "topic-a",
      "partition": 4,
      "replicas": [2,4,7]
    },
    {
      "topic": "topic-b",
      "partition": 2,
      "replicas": [1,5,7]
    }
  ]
}
```

Partitions not included in the JSON are not changed.

7.2.2. Generating reassignment JSON files

The easiest way to assign all the partitions for a given set of topics to a given set of brokers is to generate a reassignment JSON file using the **kafka-reassign-partitions.sh --generate**, command.

```
bin/kafka-reassign-partitions.sh --zookeeper <ZooKeeper> --topics-to-move-json-file <TopicsFile> --broker-list <BrokerList> --generate
```

The ***<TopicsFile>*** is a JSON file which lists the topics to move. It has the following structure:

```
{
```

```
  "version": 1,
  "topics": [
    <TopicObjects>
  ]
}
```

where *<TopicObjects>* is a comma-separated list of objects like:

```
{
  "topic": <TopicName>
}
```

For example to move all the partitions of **topic-a** and **topic-b** to brokers **4** and **7**

```
bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --topics-to-move-json-file topics-to-be-moved.json --broker-list 4,7 --generate
```

where **topics-to-be-moved.json** has contents:

```
{
  "version": 1,
  "topics": [
    { "topic": "topic-a"},
    { "topic": "topic-b"}
  ]
}
```

7.2.3. Creating reassignment JSON files manually

You can manually create the reassignment JSON file if you want to move specific partitions.

7.3. REASSIGNMENT THROTTLES

Reassigning partitions can be a slow process because it can require moving lots of data between brokers. To avoid this having a detrimental impact on clients it is possible to *throttle* the reassignment. Using a throttle can mean the reassignment takes longer. If the throttle is too low then the newly assigned brokers will not be able to keep up with records being published and the reassignment will never complete. If the throttle is too high then clients will be impacted. For example, for producers, this could manifest as higher than normal latency waiting for acknowledgement. For consumers, this could manifest as a drop in throughput caused by higher latency between polls.

7.4. SCALING UP A KAFKA CLUSTER

This procedure describes how to increase the number of brokers in a Kafka cluster.

Prerequisites

- An existing Kafka cluster.
- A new machine with the AMQ broker installed.
- A *reassignment JSON file* of how partitions should be reassigned to brokers in the enlarged cluster.

Procedure

1. Create a configuration file for the new broker using the same settings as for the other brokers in your cluster, except for **broker.id** which should be a number that is not already used by any of the other brokers.

2. Start the new Kafka broker passing the configuration file you created in the previous step as the argument to the **kafka-server-start.sh** script:

```
su - kafka
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

3. Verify that the Kafka broker is running.

```
jcmd | grep Kafka
```

4. Repeat the above steps for each new broker.

5. Execute the partition reassignment using the **kafka-reassign-partitions.sh** command line tool.

```
kafka-reassign-partitions.sh --zookeeper <ZooKeeperHostAndPort> --reassignment-json-file
<ReassignmentJsonFile> --execute
```

   If you are going to throttle replication you can also pass the **--throttle** option with an inter-broker throttled rate in bytes per second. For example:

```
kafka-reassign-partitions.sh --zookeeper zookeeper1:2181 --reassignment-json-file
reassignment.json --throttle 5000000 --execute
```

   This command will print out two reassignment JSON objects. The first records the current assignment for the partitions being moved. You should save this to a file in case you need to revert the reassignment later on. The second JSON object is the target reassignment you have passed in your reassignment JSON file.

6. If you need to change the throttle during reassignment you can use the same command line with a different throttled rate. For example:

```
kafka-reassign-partitions.sh --zookeeper zookeeper1:2181 --reassignment-json-file
reassignment.json --throttle 10000000 --execute
```

7. Periodically verify whether the reassignment has completed using the **kafka-reassign-partitions.sh** command line tool. This is the same command as the previous step but with the **--verify** option instead of the **--execute** option.

```
kafka-reassign-partitions.sh --zookeeper <ZooKeeperHostAndPort> --reassignment-json-file
<ReassignmentJsonFile> --verify
```

   For example:

```
kafka-reassign-partitions.sh --zookeeper zookeeper1:2181 --reassignment-json-file
reassignment.json --verify
```

8. The reassignment has finished when the **--verify** command reports each of the partitions being moved as completed successfully. This final **--verify** will also have the effect of removing any

reassignment throttles. You can now delete the revert file if you saved the JSON for reverting the assignment to their original brokers.

7.5. SCALING DOWN A KAFKA CLUSTER

Additional resources

This procedure describes how to decrease the number of brokers in a Kafka cluster.

Prerequisites

- An existing Kafka cluster.
- A *reassignment JSON file* of how partitions should be reassigned to brokers in the cluster once the broker(s) have been removed.

Procedure

1. Execute the partition reassignment using the **kafka-reassign-partitions.sh** command line tool.

   ```
   kafka-reassign-partitions.sh --zookeeper <ZooKeeperHostAndPort> --reassignment-json-file <ReassignmentJsonFile> --execute
   ```

   If you are going to throttle replication you can also pass the **--throttle** option with an inter-broker throttled rate in bytes per second. For example:

   ```
   kafka-reassign-partitions.sh --zookeeper zookeeper1:2181 --reassignment-json-file reassignment.json --throttle 5000000 --execute
   ```

   This command will print out two reassignment JSON objects. The first records the current assignment for the partitions being moved. You should save this to a file in case you need to revert the reassignment later on. The second JSON object is the target reassignment you have passed in your reassignment JSON file.

2. If you need to change the throttle during reassignment you can use the same command line with a different throttled rate. For example:

   ```
   kafka-reassign-partitions.sh --zookeeper zookeeper1:2181 --reassignment-json-file reassignment.json --throttle 10000000 --execute
   ```

3. Periodically verify whether the reassignment has completed using the **kafka-reassign-partitions.sh** command line tool. This is the same command as the previous step but with the **--verify** option instead of the **--execute** option.

   ```
   kafka-reassign-partitions.sh --zookeeper <ZooKeeperHostAndPort> --reassignment-json-file <ReassignmentJsonFile> --verify
   ```

   For example:

   ```
   kafka-reassign-partitions.sh --zookeeper zookeeper1:2181 --reassignment-json-file reassignment.json --verify
   ```

4. The reassignment has finished when the **--verify** command reports each of the partitions being

moved as completed successfully. This final **--verify** will also have the effect of removing any reassignment throttles. You can now delete the revert file if you saved the JSON for reverting the assignment to their original brokers.

5. Once all the partition reassignments have finished, the broker being removed should not have responsibility for any of the partitions in the cluster. You can verify this by checking each of the directories given in the broker's **log.dirs** configuration parameters. If any of the log directories on the broker contains a directory that does not match the extended regular expression **\.[a-z0-9]-delete$** then the broker still has live partitions and it should not be stopped.
You can check this by executing the command:

```
ls -l <LogDir> | grep -E '^d' | grep -vE '[a-zA-Z0-9.-]+\.[a-z0-9]+-delete$'
```

If the above command prints any output then the broker still has live partitions. In this case, either the reassignment has not finished, or the reassignment JSON file was incorrect.

6. Once you have confirmed that the broker has no live partitions you can stop it.

```
su - kafka
/opt/kafka/bin/kafka-server-stop.sh
```

7. Confirm that the Kafka broker is stopped.

```
jcmd | grep kafka
```

7.6. SCALING UP A ZOOKEEPER CLUSTER

This procedure describes how to add servers (nodes) to a ZooKeeper cluster. The dynamic reconfiguration feature of ZooKeeper maintains a stable ZooKeeper cluster during the scale up process.

Prerequisites

- Dynamic reconfiguration is enabled in the ZooKeeper configuration file (**reconfigEnabled=true**).
- ZooKeeper authentication is enabled and you can access the new server using the authentication mechanism.

Procedure

Perform the following steps for each ZooKeeper server, one at a time:

1. Add a server to the ZooKeeper cluster as described in Section 3.3, "Running multi-node ZooKeeper cluster" and then start ZooKeeper.
2. Note the IP address and configured access ports of the new server.
3. Start a **zookeeper-shell** session for the server. Run the following command from a machine that has access to the cluster (this might be one of the ZooKeeper nodes or your local machine, if it has access).

```
su - kafka
/opt/kafka/bin/zookeeper-shell.sh <ip-address>:<zk-port>
```

4. In the shell session, with the ZooKeeper node running, enter the following line to add the new server to the quorum as a voting member:

```
reconfig -add server.<positive-id> = <address1>:<port1>:<port2>[:role];[<client-port-address>:]<client-port>
```

For example:

```
reconfig -add server.4=172.17.0.4:2888:3888:participant;172.17.0.4:2181
```

Where **<positive-id>** is the new server ID **4**.

For the two ports, **<port1>** *2888* is for communication between ZooKeeper servers, and **<port2>** *3888* is for leader election.

The new configuration propagates to the other servers in the ZooKeeper cluster; the new server is now a full member of the quorum.

5. Repeat steps 1-4 for the other servers that you want to add.

Additional resources

- Section 7.7, "Scaling down a ZooKeeper cluster"

7.7. SCALING DOWN A ZOOKEEPER CLUSTER

This procedure describes how to remove servers (nodes) from a ZooKeeper cluster. The dynamic reconfiguration feature of ZooKeeper maintains a stable ZooKeeper cluster during the scale down process.

Prerequisites

- Dynamic reconfiguration is enabled in the ZooKeeper configuration file (**reconfigEnabled=true**).
- ZooKeeper authentication is enabled and you can access the new server using the authentication mechanism.

Procedure

Perform the following steps for each ZooKeeper server, one at a time:

1. Log in to the **zookeeper-shell** on one of the servers that will be **retained** after the scale down (for example, server 1).

NOTE

Access the server using the authentication mechanism configured for the ZooKeeper cluster.

2. Remove a server, for example server 5.

```
reconfig -remove 5
```

3. Deactivate the server that you removed.
4. Repeat steps 1-3 to reduce the cluster size.

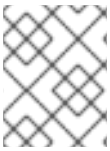
Additional resources

- Section 7.6, "Scaling up a ZooKeeper cluster"
- Removing servers in the ZooKeeper documentation

CHAPTER 8. MONITORING YOUR CLUSTER USING JMX

ZooKeeper, the Kafka broker, Kafka Connect, and the Kafka clients all expose management information using Java Management Extensions (JMX). Most management information is in the form of metrics that are useful for monitoring the condition and performance of your Kafka cluster. Like other Java applications, Kafka provides this management information through managed beans or MBeans.

JMX works at the level of the JVM (Java Virtual Machine). To obtain management information, external tools can connect to the JVM that is running ZooKeeper, the Kafka broker, and so on. By default, only tools on the same machine and running as the same user as the JVM are able to connect.



NOTE

Management information for ZooKeeper is not documented here. You can view ZooKeeper metrics in JConsole. For more information, see Monitoring using JConsole.

8.1. JMX CONFIGURATION OPTIONS

You configure JMX using JVM system properties. The scripts provided with AMQ Streams (**bin/kafka-server-start.sh** and **bin/connect-distributed.sh**, and so on) use the **KAFKA_JMX_OPTS** environment variable to set these system properties. The system properties for configuring JMX are the same, even though Kafka producer, consumer, and streams applications typically start the JVM in different ways.

8.2. DISABLING THE JMX AGENT

You can prevent local JMX tools from connecting to the JVM (for example, for compliance reasons) by disabling the JMX agent for an AMQ Streams component. The following procedure explains how to disable the JMX agent for a Kafka broker.

Procedure

1. Use the **KAFKA_JMX_OPTS** environment variable to set **com.sun.management.jmxremote** to **false**.

```
export KAFKA_JMX_OPTS=-Dcom.sun.management.jmxremote=false
bin/kafka-server-start.sh
```

2. Start the JVM.

8.3. CONNECTING TO THE JVM FROM A DIFFERENT MACHINE

You can connect to the JVM from a different machine by configuring the port that the JMX agent listens on. This is insecure because it allows JMX tools to connect from anywhere, with no authentication.

Procedure

1. Use the **KAFKA_JMX_OPTS** environment variable to set **-Dcom.sun.management.jmxremote.port=*<port>***. For ***<port>***, enter the name of the port on which you want the Kafka broker to listen for JMX connections.

```
export KAFKA_JMX_OPTS="-Dcom.sun.management.jmxremote=true
 -Dcom.sun.management.jmxremote.port=<port>
```

```
  -Dcom.sun.management.jmxremote.authenticate=false
  -Dcom.sun.management.jmxremote.ssl=false"
bin/kafka-server-start.sh
```

2. Start the JVM.

IMPORTANT

It is recommended that you configure authentication and SSL to ensure that the remote JMX connection is secure. For more information about the system properties needed to do this, see the JMX documentation.

8.4. MONITORING USING JCONSOLE

The JConsole tool is distributed with the Java Development Kit (JDK). You can use JConsole to connect to a local or remote JVM and discover and display management information from Java applications. If using JConsole to connect to a local JVM, the names of the JVM processes corresponding to the different components of AMQ Streams.

Table 8.1. JVM processes for AMQ Streams components

AMQ Streams component	JVM process
ZooKeeper	**org.apache.zookeeper.server.quorum.QuorumPeerMain**
Kafka broker	**kafka.Kafka**
Kafka Connect standalone	**org.apache.kafka.connect.cli.ConnectStandalone**
Kafka Connect distributed	**org.apache.kafka.connect.cli.ConnectDistributed**
A Kafka producer, consumer, or Streams application	The name of the class containing the **main** method for the application.

When using JConsole to connect to a remote JVM, use the appropriate host name and JMX port.

Many other tools and monitoring products can be used to fetch the metrics using JMX and provide monitoring and alerting based on those metrics. Refer to the product documentation for those tools.

8.5. IMPORTANT KAFKA BROKER METRICS

Kafka provides many MBeans for monitoring the performance of the brokers in your Kafka cluster. These apply to an individual broker rather than the entire cluster.

The following tables present a selection of these broker-level MBeans organized into server, network, logging, and controller metrics.

8.5.1. Kafka server metrics

The following table shows a selection of metrics that report information about the Kafka server.

Table 8.2. Metrics for the Kafka server

Metric	MBean	Description	Expected value
Messages in per second	**kafka.server:type=BrokerTopicMetrics,name=MessagesInPerSec**	The rate at which individual messages are consumed by the broker.	Approximately the same as the other brokers in the cluster.
Bytes in per second	**kafka.server:type=BrokerTopicMetrics,name=BytesInPerSec**	The rate at which data sent from producers is consumed by the broker.	Approximately the same as the other brokers in the cluster.
Replication bytes in per second	**kafka.server:type=BrokerTopicMetrics,name=ReplicationBytesInPerSec**	The rate at which data sent from other brokers is consumed by the follower broker.	N/A
Bytes out per second	**kafka.server:type=BrokerTopicMetrics,name=BytesOutPerSec**	The rate at which data is fetched and read from the broker by consumers.	N/A
Replication bytes out per second	**kafka.server:type=BrokerTopicMetrics,name=ReplicationBytesOutPerSec**	The rate at which data is sent from the broker to other brokers. This metric is useful to monitor if the broker is a leader for a group of partitions.	N/A
Under-replicated partitions	**kafka.server:type=ReplicaManager,name=UnderReplicatedPartitions**	The number of partitions that have not been fully replicated in the follower replicas.	Zero
Under minimum ISR partition count	**kafka.server:type=ReplicaManager,name=UnderMinIsrPartitionCount**	The number of partitions under the minimum In-Sync Replica (ISR) count. The ISR count indicates the set of replicas that are up-to-date with the leader.	Zero
Partition count	**kafka.server:type=ReplicaManager,name=PartitionCount**	The number of partitions in the broker.	Approximately even when compared with the other brokers.

Metric	MBean	Description	Expected value
Leader count	**kafka.server:type=ReplicaManager,name=LeaderCount**	The number of replicas for which this broker is the leader.	Approximately the same as the other brokers in the cluster.
ISR shrinks per second	**kafka.server:type=ReplicaManager,name=IsrShrinksPerSec**	The rate at which the number of ISRs in the broker decreases	Zero
ISR expands per second	**kafka.server:type=ReplicaManager,name=IsrExpandsPerSec**	The rate at which the number of ISRs in the broker increases.	Zero
Maximum lag	**kafka.server:type=ReplicaFetcherManager,name=MaxLag,clientId=Replica**	The maximum lag between the time that messages are received by the leader replica and by the follower replicas.	Proportional to the maximum batch size of a produce request.
Requests in producer purgatory	**kafka.server:type=DelayedOperationPurgatory,name=PurgatorySize,delayedOperation=Produce**	The number of send requests in the producer purgatory.	N/A
Requests in fetch purgatory	**kafka.server:type=DelayedOperationPurgatory,name=PurgatorySize,delayedOperation=Fetch**	The number of fetch requests in the fetch purgatory.	N/A
Request handler average idle percent	**kafka.server:type=KafkaRequestHandlerPool,name=RequestHandlerAvgIdlePercent**	Indicates the percentage of time that the request handler (IO) threads are not in use.	A lower value indicates that the workload of the broker is high.
Request (Requests exempt from throttling)	**kafka.server:type=Request**	The number of requests that are exempt from throttling.	N/A
ZooKeeper request latency in milliseconds	**kafka.server:type=ZooKeeperClientMetrics,name=ZooKeeperRequestLatencyMs**	The latency for ZooKeeper requests from the broker, in milliseconds.	N/A

Metric	MBean	Description	Expected value
ZooKeeper session state	**kafka.server:type=SessionExpireListener,name=SessionState**	The status of the broker's connection to ZooKeeper.	CONNECTED

8.5.2. Kafka network metrics

The following table shows a selection of metrics that report information about requests.

Metric	MBean	Description	Expected value
Requests per second	**kafka.network:type=RequestMetrics,name=RequestsPerSec,request={Produce|FetchConsumer|FetchFollower}**	The total number of requests made for the request type per second. The **Produce**, **FetchConsumer**, and **FetchFollower** request types each have their own MBeans.	N/A
Request bytes (request size in bytes)	**kafka.network:type=RequestMetrics,name=RequestBytes,request=([-.\w]+)**	The size of requests, in bytes, made for the request type identified by the **request** property of the MBean name. Separate MBeans for all available request types are listed under the **RequestBytes** node.	N/A
Temporary memory size in bytes	**kafka.network:type=RequestMetrics,name=TemporaryMemoryBytes,request={Produce|Fetch}**	The amount of temporary memory used for converting message formats and decompressing messages.	N/A
Message conversions time	**kafka.network:type=RequestMetrics,name=MessageConversionsTimeMs,request={Produce|Fetch}**	Time, in milliseconds, spent on converting message formats.	N/A
Total request time in milliseconds	**kafka.network:type=RequestMetrics,name=TotalTimeMs,request={Produce|FetchConsumer|FetchFollower}**	Total time, in milliseconds, spent processing requests.	N/A

Metric	MBean	Description	Expected value
Request queue time in milliseconds	**kafka.network:type=RequestMetrics,name=RequestQueueTimeMs,request={Produce|FetchConsumer|FetchFollower}**	The time, in milliseconds, that a request currently spends in the queue for the request type given in the **request** property.	N/A
Local time (leader local processing time) in milliseconds	**kafka.network:type=RequestMetrics,name=LocalTimeMs,request={Produce|FetchConsumer|FetchFollower}**	The time taken, in milliseconds, for the leader to process the request.	N/A
Remote time (leader remote processing time) in milliseconds	**kafka.network:type=RequestMetrics,name=RemoteTimeMs,request={Produce|FetchConsumer|FetchFollower}**	The length of time, in milliseconds, that the request waits for the follower. Separate MBeans for all available request types are listed under the **RemoteTimeMs** node.	N/A
Response queue time in milliseconds	**kafka.network:type=RequestMetrics,name=ResponseQueueTimeMs,request={Produce|FetchConsumer|FetchFollower}**	The length of time, in milliseconds, that the request waits in the response queue.	N/A
Response send time in milliseconds	**kafka.network:type=RequestMetrics,name=ResponseSendTimeMs,request={Produce|FetchConsumer|FetchFollower}**	The time taken, in milliseconds, to send the response.	N/A
Network processor average idle percent	**kafka.network:type=SocketServer,name=NetworkProcessorAvgIdlePercent**	The average percentage of time that the network processors are idle.	Between zero and one.

8.5.3. Kafka log metrics

The following table shows a selection of metrics that report information about logging.

Metric	MBean	Description	Expected Value
Log flush rate and time in milliseconds	**kafka.log:type=LogFlushStats,name=LogFlushRateAndTimeMs**	The rate at which log data is written to disk, in milliseconds.	N/A
Offline log directory count	**kafka.log:type=LogManager,name=OfflineLogDirectoryCount**	The number of offline log directories (for example, after a hardware failure).	Zero

8.5.4. Kafka controller metrics

The following table shows a selection of metrics that report information about the controller of the cluster.

Metric	MBean	Description	Expected Value
Active controller count	**kafka.controller:type=KafkaController,name=ActiveControllerCount**	The number of brokers designated as controllers.	One indicates that the broker is the controller for the cluster.
Leader election rate and time in milliseconds	**kafka.controller:type=ControllerStats,name=LeaderElectionRateAndTimeMs**	The rate at which new leader replicas are elected.	Zero

8.5.5. Yammer metrics

Metrics that express a rate or unit of time are provided as Yammer metrics. The class name of an MBean that uses Yammer metrics is prefixed with **com.yammer.metrics**.

Yammer rate metrics have the following attributes for monitoring requests:

- Count
- EventType (Bytes)
- FifteenMinuteRate
- RateUnit (Seconds)
- MeanRate
- OneMinuteRate
- FiveMinuteRate

Yammer time metrics have the following attributes for monitoring requests:

- Max
- Min
- Mean
- StdDev
- 75/95/98/99/99.9th Percentile

8.6. PRODUCER MBEANS

The following MBeans will exist in Kafka producer applications, including Kafka Streams applications and Kafka Connect with source connectors.

8.6.1. MBeans matching **kafka.producer:type=producer-metrics,client-id=***

These are metrics at the producer level.

Attribute	Description
batch-size-avg	The average number of bytes sent per partition per-request.
batch-size-max	The max number of bytes sent per partition per-request.
batch-split-rate	The average number of batch splits per second.
batch-split-total	The total number of batch splits.
buffer-available-bytes	The total amount of buffer memory that is not being used (either unallocated or in the free list).
buffer-total-bytes	The maximum amount of buffer memory the client can use (whether or not it is currently used).
bufferpool-wait-time	The fraction of time an appender waits for space allocation.
compression-rate-avg	The average compression rate of record batches.
connection-close-rate	Connections closed per second in the window.
connection-count	The current number of active connections.
connection-creation-rate	New connections established per second in the window.

Attribute	Description
failed-authentication-rate	Connections that failed authentication.
incoming-byte-rate	Bytes/second read off all sockets.
io-ratio	The fraction of time the I/O thread spent doing I/O.
io-time-ns-avg	The average length of time for I/O per select call in nanoseconds.
io-wait-ratio	The fraction of time the I/O thread spent waiting.
io-wait-time-ns-avg	The average length of time the I/O thread spent waiting for a socket ready for reads or writes in nanoseconds.
metadata-age	The age in seconds of the current producer metadata being used.
network-io-rate	The average number of network operations (reads or writes) on all connections per second.
outgoing-byte-rate	The average number of outgoing bytes sent per second to all servers.
produce-throttle-time-avg	The average time in ms a request was throttled by a broker.
produce-throttle-time-max	The maximum time in ms a request was throttled by a broker.
record-error-rate	The average per-second number of record sends that resulted in errors.
record-error-total	The total number of record sends that resulted in errors.
record-queue-time-avg	The average time in ms record batches spent in the send buffer.
record-queue-time-max	The maximum time in ms record batches spent in the send buffer.
record-retry-rate	The average per-second number of retried record sends.
record-retry-total	The total number of retried record sends.

Attribute	Description
record-send-rate	The average number of records sent per second.
record-send-total	The total number of records sent.
record-size-avg	The average record size.
record-size-max	The maximum record size.
records-per-request-avg	The average number of records per request.
request-latency-avg	The average request latency in ms.
request-latency-max	The maximum request latency in ms.
request-rate	The average number of requests sent per second.
request-size-avg	The average size of all requests in the window.
request-size-max	The maximum size of any request sent in the window.
requests-in-flight	The current number of in-flight requests awaiting a response.
response-rate	Responses received sent per second.
select-rate	Number of times the I/O layer checked for new I/O to perform per second.
successful-authentication-rate	Connections that were successfully authenticated using SASL or SSL.
waiting-threads	The number of user threads blocked waiting for buffer memory to enqueue their records.

8.6.2. MBeans matching kafka.producer:type=producer-metrics,client-id=*,node-id=*

These are metrics at the producer level about connection to each broker.

Attribute	Description
incoming-byte-rate	The average number of responses received per second for a node.
outgoing-byte-rate	The average number of outgoing bytes sent per second for a node.

Attribute	Description
request-latency-avg	The average request latency in ms for a node.
request-latency-max	The maximum request latency in ms for a node.
request-rate	The average number of requests sent per second for a node.
request-size-avg	The average size of all requests in the window for a node.
request-size-max	The maximum size of any request sent in the window for a node.
response-rate	Responses received sent per second for a node.

8.6.3. MBeans matching kafka.producer:type=producer-topic-metrics,client-id=*,topic=*

These are metrics at the topic level about topics the producer is sending messages to.

Attribute	Description
byte-rate	The average number of bytes sent per second for a topic.
byte-total	The total number of bytes sent for a topic.
compression-rate	The average compression rate of record batches for a topic.
record-error-rate	The average per-second number of record sends that resulted in errors for a topic.
record-error-total	The total number of record sends that resulted in errors for a topic.
record-retry-rate	The average per-second number of retried record sends for a topic.
record-retry-total	The total number of retried record sends for a topic.
record-send-rate	The average number of records sent per second for a topic.
record-send-total	The total number of records sent for a topic.

8.7. CONSUMER MBEANS

The following MBeans will exist in Kafka consumer applications, including Kafka Streams applications and Kafka Connect with sink connectors.

8.7.1. MBeans matching `kafka.consumer:type=consumer-metrics,client-id=*`

These are metrics at the consumer level.

Attribute	Description
connection-close-rate	Connections closed per second in the window.
connection-count	The current number of active connections.
connection-creation-rate	New connections established per second in the window.
failed-authentication-rate	Connections that failed authentication.
incoming-byte-rate	Bytes/second read off all sockets.
io-ratio	The fraction of time the I/O thread spent doing I/O.
io-time-ns-avg	The average length of time for I/O per select call in nanoseconds.
io-wait-ratio	The fraction of time the I/O thread spent waiting.
io-wait-time-ns-avg	The average length of time the I/O thread spent waiting for a socket ready for reads or writes in nanoseconds.
network-io-rate	The average number of network operations (reads or writes) on all connections per second.
outgoing-byte-rate	The average number of outgoing bytes sent per second to all servers.
request-rate	The average number of requests sent per second.
request-size-avg	The average size of all requests in the window.
request-size-max	The maximum size of any request sent in the window.
response-rate	Responses received sent per second.
select-rate	Number of times the I/O layer checked for new I/O to perform per second.

Attribute	Description
successful-authentication-rate	Connections that were successfully authenticated using SASL or SSL.

8.7.2. MBeans matching kafka.consumer:type=consumer-metrics,client-id=*,node-id=*

These are metrics at the consumer level about connection to each broker.

Attribute	Description
incoming-byte-rate	The average number of responses received per second for a node.
outgoing-byte-rate	The average number of outgoing bytes sent per second for a node.
request-latency-avg	The average request latency in ms for a node.
request-latency-max	The maximum request latency in ms for a node.
request-rate	The average number of requests sent per second for a node.
request-size-avg	The average size of all requests in the window for a node.
request-size-max	The maximum size of any request sent in the window for a node.
response-rate	Responses received sent per second for a node.

8.7.3. MBeans matching kafka.consumer:type=consumer-coordinator-metrics,client-id=*

These are metrics at the consumer level about the consumer group.

Attribute	Description
assigned-partitions	The number of partitions currently assigned to this consumer.
commit-latency-avg	The average time taken for a commit request.
commit-latency-max	The max time taken for a commit request.

Attribute	Description
commit-rate	The number of commit calls per second.
heartbeat-rate	The average number of heartbeats per second.
heartbeat-response-time-max	The max time taken to receive a response to a heartbeat request.
join-rate	The number of group joins per second.
join-time-avg	The average time taken for a group rejoin.
join-time-max	The max time taken for a group rejoin.
last-heartbeat-seconds-ago	The number of seconds since the last controller heartbeat.
sync-rate	The number of group syncs per second.
sync-time-avg	The average time taken for a group sync.
sync-time-max	The max time taken for a group sync.

8.7.4. MBeans matching kafka.consumer:type=consumer-fetch-manager-metrics,client-id=*

These are metrics at the consumer level about the consumer's fetcher.

Attribute	Description
bytes-consumed-rate	The average number of bytes consumed per second.
bytes-consumed-total	The total number of bytes consumed.
fetch-latency-avg	The average time taken for a fetch request.
fetch-latency-max	The max time taken for any fetch request.
fetch-rate	The number of fetch requests per second.
fetch-size-avg	The average number of bytes fetched per request.
fetch-size-max	The maximum number of bytes fetched per request.

Attribute	Description
fetch-throttle-time-avg	The average throttle time in ms.
fetch-throttle-time-max	The maximum throttle time in ms.
fetch-total	The total number of fetch requests.
records-consumed-rate	The average number of records consumed per second.
records-consumed-total	The total number of records consumed.
records-lag-max	The maximum lag in terms of number of records for any partition in this window.
records-lead-min	The minimum lead in terms of number of records for any partition in this window.
records-per-request-avg	The average number of records in each request.

8.7.5. MBeans matching **kafka.consumer:type=consumer-fetch-manager-metrics,client-id=*,topic=***

These are metrics at the topic level about the consumer's fetcher.

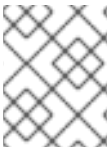
Attribute	Description
bytes-consumed-rate	The average number of bytes consumed per second for a topic.
bytes-consumed-total	The total number of bytes consumed for a topic.
fetch-size-avg	The average number of bytes fetched per request for a topic.
fetch-size-max	The maximum number of bytes fetched per request for a topic.
records-consumed-rate	The average number of records consumed per second for a topic.
records-consumed-total	The total number of records consumed for a topic.
records-per-request-avg	The average number of records in each request for a topic.

8.7.6. MBeans matching kafka.consumer:type=consumer-fetch-manager-metrics,client-id=*,topic=*,partition=*

These are metrics at the partition level about the consumer's fetcher.

Attribute	Description
preferred-read-replica	The current read replica for the partition, or -1 if reading from leader.
records-lag	The latest lag of the partition.
records-lag-avg	The average lag of the partition.
records-lag-max	The max lag of the partition.
records-lead	The latest lead of the partition.
records-lead-avg	The average lead of the partition.
records-lead-min	The min lead of the partition.

8.8. KAFKA CONNECT MBEANS



NOTE

Kafka Connect will contain the producer MBeans for source connectors and consumer MBeans for sink connectors in addition to those documented here.

8.8.1. MBeans matching kafka.connect:type=connect-metrics,client-id=*

These are metrics at the connect level.

Attribute	Description
connection-close-rate	Connections closed per second in the window.
connection-count	The current number of active connections.
connection-creation-rate	New connections established per second in the window.
failed-authentication-rate	Connections that failed authentication.
incoming-byte-rate	Bytes/second read off all sockets.
io-ratio	The fraction of time the I/O thread spent doing I/O.

Attribute	Description
io-time-ns-avg	The average length of time for I/O per select call in nanoseconds.
io-wait-ratio	The fraction of time the I/O thread spent waiting.
io-wait-time-ns-avg	The average length of time the I/O thread spent waiting for a socket ready for reads or writes in nanoseconds.
network-io-rate	The average number of network operations (reads or writes) on all connections per second.
outgoing-byte-rate	The average number of outgoing bytes sent per second to all servers.
request-rate	The average number of requests sent per second.
request-size-avg	The average size of all requests in the window.
request-size-max	The maximum size of any request sent in the window.
response-rate	Responses received sent per second.
select-rate	Number of times the I/O layer checked for new I/O to perform per second.
successful-authentication-rate	Connections that were successfully authenticated using SASL or SSL.

8.8.2. MBeans matching **kafka.connect:type=connect-metrics,client-id=*,node-id=***

These are metrics at the connect level about connection to each broker.

Attribute	Description
incoming-byte-rate	The average number of responses received per second for a node.
outgoing-byte-rate	The average number of outgoing bytes sent per second for a node.
request-latency-avg	The average request latency in ms for a node.
request-latency-max	The maximum request latency in ms for a node.

Attribute	Description
request-rate	The average number of requests sent per second for a node.
request-size-avg	The average size of all requests in the window for a node.
request-size-max	The maximum size of any request sent in the window for a node.
response-rate	Responses received sent per second for a node.

8.8.3. MBeans matching kafka.connect:type=connect-worker-metrics

These are metrics at the connect level.

Attribute	Description
connector-count	The number of connectors run in this worker.
connector-startup-attempts-total	The total number of connector startups that this worker has attempted.
connector-startup-failure-percentage	The average percentage of this worker's connectors starts that failed.
connector-startup-failure-total	The total number of connector starts that failed.
connector-startup-success-percentage	The average percentage of this worker's connectors starts that succeeded.
connector-startup-success-total	The total number of connector starts that succeeded.
task-count	The number of tasks run in this worker.
task-startup-attempts-total	The total number of task startups that this worker has attempted.
task-startup-failure-percentage	The average percentage of this worker's tasks starts that failed.
task-startup-failure-total	The total number of task starts that failed.

Attribute	Description
task-startup-success-percentage	The average percentage of this worker's tasks starts that succeeded.
task-startup-success-total	The total number of task starts that succeeded.

8.8.4. MBeans matching kafka.connect:type=connect-worker-rebalance-metrics

Attribute	Description
completed-rebalances-total	The total number of rebalances completed by this worker.
connect-protocol	The Connect protocol used by this cluster.
epoch	The epoch or generation number of this worker.
leader-name	The name of the group leader.
rebalance-avg-time-ms	The average time in milliseconds spent by this worker to rebalance.
rebalance-max-time-ms	The maximum time in milliseconds spent by this worker to rebalance.
rebalancing	Whether this worker is currently rebalancing.
time-since-last-rebalance-ms	The time in milliseconds since this worker completed the most recent rebalance.

8.8.5. MBeans matching kafka.connect:type=connector-metrics,connector=*

Attribute	Description
connector-class	The name of the connector class.
connector-type	The type of the connector. One of 'source' or 'sink'.
connector-version	The version of the connector class, as reported by the connector.
status	The status of the connector. One of 'unassigned', 'running', 'paused', 'failed', or 'destroyed'.

8.8.6. MBeans matching kafka.connect:type=connector-task-metrics,connector=*,task=*

Attribute	Description
batch-size-avg	The average size of the batches processed by the connector.
batch-size-max	The maximum size of the batches processed by the connector.
offset-commit-avg-time-ms	The average time in milliseconds taken by this task to commit offsets.
offset-commit-failure-percentage	The average percentage of this task's offset commit attempts that failed.
offset-commit-max-time-ms	The maximum time in milliseconds taken by this task to commit offsets.
offset-commit-success-percentage	The average percentage of this task's offset commit attempts that succeeded.
pause-ratio	The fraction of time this task has spent in the pause state.
running-ratio	The fraction of time this task has spent in the running state.
status	The status of the connector task. One of 'unassigned', 'running', 'paused', 'failed', or 'destroyed'.

8.8.7. MBeans matching kafka.connect:type=sink-task-metrics,connector=*,task=*

Attribute	Description
offset-commit-completion-rate	The average per-second number of offset commit completions that were completed successfully.
offset-commit-completion-total	The total number of offset commit completions that were completed successfully.
offset-commit-seq-no	The current sequence number for offset commits.
offset-commit-skip-rate	The average per-second number of offset commit completions that were received too late and skipped/ignored.

Attribute	Description
offset-commit-skip-total	The total number of offset commit completions that were received too late and skipped/ignored.
partition-count	The number of topic partitions assigned to this task belonging to the named sink connector in this worker.
put-batch-avg-time-ms	The average time taken by this task to put a batch of sinks records.
put-batch-max-time-ms	The maximum time taken by this task to put a batch of sinks records.
sink-record-active-count	The number of records that have been read from Kafka but not yet completely committed/flushed/acknowledged by the sink task.
sink-record-active-count-avg	The average number of records that have been read from Kafka but not yet completely committed/flushed/acknowledged by the sink task.
sink-record-active-count-max	The maximum number of records that have been read from Kafka but not yet completely committed/flushed/acknowledged by the sink task.
sink-record-lag-max	The maximum lag in terms of number of records that the sink task is behind the consumer's position for any topic partitions.
sink-record-read-rate	The average per-second number of records read from Kafka for this task belonging to the named sink connector in this worker. This is before transformations are applied.
sink-record-read-total	The total number of records read from Kafka by this task belonging to the named sink connector in this worker, since the task was last restarted.
sink-record-send-rate	The average per-second number of records output from the transformations and sent/put to this task belonging to the named sink connector in this worker. This is after transformations are applied and excludes any records filtered out by the transformations.
sink-record-send-total	The total number of records output from the transformations and sent/put to this task belonging to the named sink connector in this worker, since the task was last restarted.

8.8.8. MBeans matching kafka.connect:type=source-task-metrics,connector=*,task=*

Attribute	Description
poll-batch-avg-time-ms	The average time in milliseconds taken by this task to poll for a batch of source records.
poll-batch-max-time-ms	The maximum time in milliseconds taken by this task to poll for a batch of source records.
source-record-active-count	The number of records that have been produced by this task but not yet completely written to Kafka.
source-record-active-count-avg	The average number of records that have been produced by this task but not yet completely written to Kafka.
source-record-active-count-max	The maximum number of records that have been produced by this task but not yet completely written to Kafka.
source-record-poll-rate	The average per-second number of records produced/polled (before transformation) by this task belonging to the named source connector in this worker.
source-record-poll-total	The total number of records produced/polled (before transformation) by this task belonging to the named source connector in this worker.
source-record-write-rate	The average per-second number of records output from the transformations and written to Kafka for this task belonging to the named source connector in this worker. This is after transformations are applied and excludes any records filtered out by the transformations.
source-record-write-total	The number of records output from the transformations and written to Kafka for this task belonging to the named source connector in this worker, since the task was last restarted.

8.8.9. MBeans matching kafka.connect:type=task-error-metrics,connector=*,task=*

Attribute	Description
deadletterqueue-produce-failures	The number of failed writes to the dead letter queue.

Attribute	Description
deadletterqueue-produce-requests	The number of attempted writes to the dead letter queue.
last-error-timestamp	The epoch timestamp when this task last encountered an error.
total-errors-logged	The number of errors that were logged.
total-record-errors	The number of record processing errors in this task.
total-record-failures	The number of record processing failures in this task.
total-records-skipped	The number of records skipped due to errors.
total-retries	The number of operations retried.

8.9. KAFKA STREAMS MBEANS

NOTE

A Streams application will contain the producer and consumer MBeans in addition to those documented here.

8.9.1. MBeans matching kafka.streams:type=stream-metrics,client-id=*

These metrics are collected when the **metrics.recording.level** configuration parameter is **info** or **debug**.

Attribute	Description
commit-latency-avg	The average execution time in ms for committing, across all running tasks of this thread.
commit-latency-max	The maximum execution time in ms for committing across all running tasks of this thread.
commit-rate	The average number of commits per second.
commit-total	The total number of commit calls across all tasks.
poll-latency-avg	The average execution time in ms for polling, across all running tasks of this thread.
poll-latency-max	The maximum execution time in ms for polling across all running tasks of this thread.

Attribute	Description
poll-rate	The average number of polls per second.
poll-total	The total number of poll calls across all tasks.
process-latency-avg	The average execution time in ms for processing, across all running tasks of this thread.
process-latency-max	The maximum execution time in ms for processing across all running tasks of this thread.
process-rate	The average number of process calls per second.
process-total	The total number of process calls across all tasks.
punctuate-latency-avg	The average execution time in ms for punctuating, across all running tasks of this thread.
punctuate-latency-max	The maximum execution time in ms for punctuating across all running tasks of this thread.
punctuate-rate	The average number of punctuates per second.
punctuate-total	The total number of punctuate calls across all tasks.
skipped-records-rate	The average number of skipped records per second.
skipped-records-total	The total number of skipped records.
task-closed-rate	The average number of tasks closed per second.
task-closed-total	The total number of tasks closed.
task-created-rate	The average number of newly created tasks per second.
task-created-total	The total number of tasks created.

8.9.2. MBeans matching **kafka.streams:type=stream-task-metrics,client-id=*,task-id=***

Task metrics.

These metrics are collected when the **metrics.recording.level** configuration parameter is **debug**.

Attribute	Description
commit-latency-avg	The average commit time in ns for this task.
commit-latency-max	The maximum commit time in ns for this task.
commit-rate	The average number of commit calls per second.
commit-total	The total number of commit calls.

8.9.3. MBeans matching **kafka.streams:type=stream-processor-node-metrics,client-id=*,task-id=*,processor-node-id=***

Processor node metrics.

These metrics are collected when the **metrics.recording.level** configuration parameter is **debug**.

Attribute	Description
create-latency-avg	The average create execution time in ns.
create-latency-max	The maximum create execution time in ns.
create-rate	The average number of create operations per second.
create-total	The total number of create operations called.
destroy-latency-avg	The average destroy execution time in ns.
destroy-latency-max	The maximum destroy execution time in ns.
destroy-rate	The average number of destroy operations per second.
destroy-total	The total number of destroy operations called.
forward-rate	The average rate of records being forwarded downstream, from source nodes only, per second.
forward-total	The total number of of records being forwarded downstream, from source nodes only.
process-latency-avg	The average process execution time in ns.
process-latency-max	The maximum process execution time in ns.

Attribute	Description
process-rate	The average number of process operations per second.
process-total	The total number of process operations called.
punctuate-latency-avg	The average punctuate execution time in ns.
punctuate-latency-max	The maximum punctuate execution time in ns.
punctuate-rate	The average number of punctuate operations per second.
punctuate-total	The total number of punctuate operations called.

8.9.4. MBeans matching **kafka.streams:type=stream-[store-scope]-metrics,client-id=*,task-id=*,[store-scope]-id=***

State store metrics.

These metrics are collected when the **metrics.recording.level** configuration parameter is **debug**.

Attribute	Description
all-latency-avg	The average all operation execution time in ns.
all-latency-max	The maximum all operation execution time in ns.
all-rate	The average all operation rate for this store.
all-total	The total number of all operation calls for this store.
delete-latency-avg	The average delete execution time in ns.
delete-latency-max	The maximum delete execution time in ns.
delete-rate	The average delete rate for this store.
delete-total	The total number of delete calls for this store.
flush-latency-avg	The average flush execution time in ns.
flush-latency-max	The maximum flush execution time in ns.
flush-rate	The average flush rate for this store.

Attribute	Description
flush-total	The total number of flush calls for this store.
get-latency-avg	The average get execution time in ns.
get-latency-max	The maximum get execution time in ns.
get-rate	The average get rate for this store.
get-total	The total number of get calls for this store.
put-all-latency-avg	The average put-all execution time in ns.
put-all-latency-max	The maximum put-all execution time in ns.
put-all-rate	The average put-all rate for this store.
put-all-total	The total number of put-all calls for this store.
put-if-absent-latency-avg	The average put-if-absent execution time in ns.
put-if-absent-latency-max	The maximum put-if-absent execution time in ns.
put-if-absent-rate	The average put-if-absent rate for this store.
put-if-absent-total	The total number of put-if-absent calls for this store.
put-latency-avg	The average put execution time in ns.
put-latency-max	The maximum put execution time in ns.
put-rate	The average put rate for this store.
put-total	The total number of put calls for this store.
range-latency-avg	The average range execution time in ns.
range-latency-max	The maximum range execution time in ns.
range-rate	The average range rate for this store.
range-total	The total number of range calls for this store.
restore-latency-avg	The average restore execution time in ns.
restore-latency-max	The maximum restore execution time in ns.

Attribute	Description
restore-rate	The average restore rate for this store.
restore-total	The total number of restore calls for this store.

8.9.5. MBeans matching **kafka.streams:type=stream-record-cache-metrics,client-id=*,task-id=*,record-cache-id=***

Record cache metrics.

These metrics are collected when the **metrics.recording.level** configuration parameter is **debug**.

Attribute	Description
hitRatio-avg	The average cache hit ratio defined as the ratio of cache read hits over the total cache read requests.
hitRatio-max	The maximum cache hit ratio.
hitRatio-min	The mininum cache hit ratio.

CHAPTER 9. KAFKA CONNECT

Kafka Connect is a tool for streaming data between Apache Kafka and external systems. It provides a framework for moving large amounts of data while maintaining scalability and reliability. Kafka Connect is typically used to integrate Kafka with database, storage, and messaging systems that are external to your Kafka cluster.

Kafka Connect uses connector plug-ins that implement connectivity for different types of external systems. There are two types of connector plug-ins: sink and source. Sink connectors stream data from Kafka to external systems. Source connectors stream data from external systems into Kafka.

Kafka Connect can run in standalone or distributed modes.

Standalone mode

In standalone mode, Kafka Connect runs on a single node with user-defined configuration read from a properties file.

Distributed mode

In distributed mode, Kafka Connect runs across one or more worker nodes and the workloads are distributed among them. You manage connectors and their configuration using an HTTP REST interface.

9.1. KAFKA CONNECT IN STANDALONE MODE

In standalone mode, Kafka Connect runs as a single process, on a single node. You manage the configuration of standalone mode using properties files.

9.1.1. Configuring Kafka Connect in standalone mode

To configure Kafka Connect in standalone mode, edit the **config/connect-standalone.properties** configuration file. The following options are the most important.

bootstrap.servers

A list of Kafka broker addresses used as bootstrap connections to Kafka. For example, **kafka0.my-domain.com:9092,kafka1.my-domain.com:9092,kafka2.my-domain.com:9092**.

key.converter

The class used to convert message keys to and from Kafka format. For example, **org.apache.kafka.connect.json.JsonConverter**.

value.converter

The class used to convert message payloads to and from Kafka format. For example, **org.apache.kafka.connect.json.JsonConverter**.

offset.storage.file.filename

Specifies the file in which the offset data is stored.

An example configuration file is provided in the installation directory at **config/connect-standalone.properties**. For a complete list of all supported Kafka Connect configuration options, see [kafka-connect-configuration-parameters-str].

Connector plug-ins open client connections to the Kafka brokers using the bootstrap address. To configure these connections, use the standard Kafka producer and consumer configuration options prefixed by **producer.** or **consumer.**.

For more information on configuring Kafka producers and consumers, see:

- Appendix D, *Producer configuration parameters*
- Appendix C, *Consumer configuration parameters*

9.1.2. Configuring connectors in Kafka Connect in standalone mode

You can configure connector plug-ins for Kafka Connect in standalone mode using properties files. Most configuration options are specific to each connector. The following options apply to all connectors:

name

The name of the connector, which must be unique within the current Kafka Connect instance.

connector.class

The class of the connector plug-in. For example, **org.apache.kafka.connect.file.FileStreamSinkConnector**.

tasks.max

The maximum number of tasks that the specified connector can use. Tasks enable the connector to perform work in parallel. The connector might create fewer tasks than specified.

key.converter

The class used to convert message keys to and from Kafka format. This overrides the default value set by the Kafka Connect configuration. For example, **org.apache.kafka.connect.json.JsonConverter**.

value.converter

The class used to convert message payloads to and from Kafka format. This overrides the default value set by the Kafka Connect configuration. For example, **org.apache.kafka.connect.json.JsonConverter**.

Additionally, you must set at least one of the following options for sink connectors:

topics

A comma-separated list of topics used as input.

topics.regex

A Java regular expression of topics used as input.

For all other options, see the documentation for the available connectors.

AMQ Streams includes example connector configuration files – see **config/connect-file-sink.properties** and **config/connect-file-source.properties** in the AMQ Streams installation directory.

9.1.3. Running Kafka Connect in standalone mode

This procedure describes how to configure and run Kafka Connect in standalone mode.

Prerequisites

- An installed and running AMQ Streams} cluster.

Procedure

1. Edit the **/opt/kafka/config/connect-standalone.properties** Kafka Connect configuration file and set **bootstrap.server** to point to your Kafka brokers. For example:

```
bootstrap.servers=kafka0.my-domain.com:9092,kafka1.my-domain.com:9092,kafka2.my-domain.com:9092
```

2. Start Kafka Connect with the configuration file and specify one or more connector configurations.

```
su - kafka
/opt/kafka/bin/connect-standalone.sh /opt/kafka/config/connect-standalone.properties connector1.properties
[connector2.properties ...]
```

3. Verify that Kafka Connect is running.

```
jcmd | grep ConnectStandalone
```

Additional resources

- For more information on installing AMQ Streams, see Section 2.3, "Installing AMQ Streams".
- For more information on configuring AMQ Streams, see Section 2.8, "Configuring AMQ Streams".
- For a complete list of supported Kafka Connect configuration options, see Appendix F, *Kafka Connect configuration parameters*.

9.2. KAFKA CONNECT IN DISTRIBUTED MODE

In distributed mode, Kafka Connect runs across one or more worker nodes and the workloads are distributed among them. You manage connector plug-ins and their configuration using the HTTP REST interface.

9.2.1. Configuring Kafka Connect in distributed mode

To configure Kafka Connect in distributed mode, edit the **config/connect-distributed.properties** configuration file. The following options are the most important.

bootstrap.servers

A list of Kafka broker addresses used as bootstrap connections to Kafka. For example, **kafka0.my-domain.com:9092,kafka1.my-domain.com:9092,kafka2.my-domain.com:9092**.

key.converter

The class used to convert message keys to and from Kafka format. For example, **org.apache.kafka.connect.json.JsonConverter**.

value.converter

The class used to convert message payloads to and from Kafka format. For example, **org.apache.kafka.connect.json.JsonConverter**.

group.id

The name of the distributed Kafka Connect cluster. This must be unique and must not conflict with another consumer group ID. The default value is **connect-cluster**.

config.storage.topic

The Kafka topic used to store connector configurations. The default value is **connect-configs**.

offset.storage.topic

The Kafka topic used to store offsets. The default value is **connect-offset**.

status.storage.topic

The Kafka topic used for worker node statuses. The default value is **connect-status**.

AMQ Streams includes an example configuration file for Kafka Connect in distributed mode – see **config/connect-distributed.properties** in the AMQ Streams installation directory.

For a complete list of all supported Kafka Connect configuration options, see Appendix F, *Kafka Connect configuration parameters*.

Connector plug-ins open client connections to the Kafka brokers using the bootstrap address. To configure these connections, use the standard Kafka producer and consumer configuration options prefixed by **producer.** or **consumer.**.

For more information on configuring Kafka producers and consumers, see:

- Appendix D, *Producer configuration parameters*
- Appendix C, *Consumer configuration parameters*

9.2.2. Configuring connectors in distributed Kafka Connect

HTTP REST Interface

Connectors for distributed Kafka Connect are configured using HTTP REST interface. The REST interface listens on port 8083 by default. It supports following endpoints:

GET /connectors

Return a list of existing connectors.

POST /connectors

Create a connector. The request body has to be a JSON object with the connector configuration.

GET /connectors/*<name>*

Get information about a specific connector.

GET /connectors/*<name>*/config

Get configuration of a specific connector.

PUT /connectors/*<name>*/config

Update the configuration of a specific connector.

GET /connectors/*<name>*/status

Get the status of a specific connector.

PUT /connectors/*<name>*/pause

Pause the connector and all its tasks. The connector will stop processing any messages.

PUT /connectors/*<name>*/resume

Resume a paused connector.

POST /connectors/*<name>*/restart

Restart a connector in case it has failed.

DELETE /connectors/*<name>*

Delete a connector.

GET /connector-plugins

Get a list of all supported connector plugins.

Connector configuration

Most configuration options are connector specific and included in the documentation for the connectors. The following fields are common for all connectors.

name

Name of the connector. Must be unique within a given Kafka Connect instance.

connector.class

Class of the connector plugin. For example **org.apache.kafka.connect.file.FileStreamSinkConnector**.

tasks.max

The maximum number of tasks used by this connector. Tasks are used by the connector to parallelise its work. Connetors may create fewer tasks than specified.

key.converter

Class used to convert message keys to and from Kafka format. This overrides the default value set by the Kafka Connect configuration. For example, **org.apache.kafka.connect.json.JsonConverter**.

value.converter

Class used to convert message payloads to and from Kafka format. This overrides the default value set by the Kafka Connect configuration. For example, **org.apache.kafka.connect.json.JsonConverter**.

Additionally, one of the following options must be set for sink connectors:

topics

A comma-separated list of topics used as input.

topics.regex

A Java regular expression of topics used as input.

For all other options, see the documentation for the specific connector.

AMQ Streams includes example connector configuration files. They can be found in **config/connect-file-sink.properties** and **config/connect-file-source.properties** in the AMQ Streams installation directory.

9.2.3. Running distributed Kafka Connect

This procedure describes how to configure and run Kafka Connect in distributed mode.

Prerequisites

- An installed and running AMQ Streams cluster.

Running the cluster

1. Edit the **/opt/kafka/config/connect-distributed.properties** Kafka Connect configuration file on all Kafka Connect worker nodes.
    - Set the **bootstrap.server** option to point to your Kafka brokers.

- Set the **group.id** option.
- Set the **config.storage.topic** option.
- Set the **offset.storage.topic** option.
- Set the **status.storage.topic** option.
  For example:

```
bootstrap.servers=kafka0.my-domain.com:9092,kafka1.my-domain.com:9092,kafka2.my-domain.com:9092
group.id=my-group-id
config.storage.topic=my-group-id-configs
offset.storage.topic=my-group-id-offsets
status.storage.topic=my-group-id-status
```

2. Start the Kafka Connect workers with the **/opt/kafka/config/connect-distributed.properties** configuration file on all Kafka Connect nodes.

```
su - kafka
/opt/kafka/bin/connect-distributed.sh /opt/kafka/config/connect-distributed.properties
```

3. Verify that Kafka Connect is running.

```
jcmd | grep ConnectDistributed
```

Additional resources

- For more information about installing AMQ Streams, see Section 2.3, “Installing AMQ Streams”.
- For more information about configuring AMQ Streams, see Section 2.8, “Configuring AMQ Streams”.
- For a complete list of supported Kafka Connect configuration options, see Appendix F, *Kafka Connect configuration parameters*.

9.2.4. Creating connectors

This procedure describes how to use the Kafka Connect REST API to create a connector plug-in for use with Kafka Connect in distributed mode.

Prerequisites

- A Kafka Connect installation running in distributed mode.

Procedure

1. Prepare a JSON payload with the connector configuration. For example:

```
{
  "name": "my-connector",
  "config": {
  "connector.class": "org.apache.kafka.connect.file.FileStreamSinkConnector",
    "tasks.max": "1",
```

```
    "topics": "my-topic-1,my-topic-2",
    "file": "/tmp/output-file.txt"
  }
}
```

2. Send a POST request to ***<KafkaConnectAddress>*:8083/connectors** to create the connector. The following example uses **curl**:

```
curl -X POST -H "Content-Type: application/json" --data @sink-connector.json
http://connect0.my-domain.com:8083/connectors
```

3. Verify that the connector was deployed by sending a GET request to ***<KafkaConnectAddress>*:8083/connectors**. The following example uses **curl**:

```
curl http://connect0.my-domain.com:8083/connectors
```

9.2.5. Deleting connectors

This procedure describes how to use the Kafka Connect REST API to delete a connector plug-in from Kafka Connect in distributed mode.

Prerequisites

- A Kafka Connect installation running in distributed mode.

Deleting connectors

1. Verify that the connector exists by sending a **GET** request to ***<KafkaConnectAddress>*:8083/connectors/*<ConnectorName>***. The following example uses **curl**:

```
curl http://connect0.my-domain.com:8083/connectors
```

2. To delete the connector, send a **DELETE** request to ***<KafkaConnectAddress>*:8083/connectors**. The following example uses **curl**:

```
curl -X DELETE http://connect0.my-domain.com:8083/connectors/my-connector
```

3. Verify that the connector was deleted by sending a GET request to ***<KafkaConnectAddress>*:8083/connectors**. The following example uses **curl**:

```
curl http://connect0.my-domain.com:8083/connectors
```

9.3. CONNECTOR PLUG-INS

The following connector plug-ins are included with AMQ Streams.

FileStreamSink Reads data from Kafka topics and writes the data to a file.

FileStreamSource Reads data from a file and sends the data to Kafka topics.

You can add more connector plug-ins if needed. Kafka Connect searches for and runs additional connector plug-ins at startup. To define the path that kafka Connect searches for plug-ins, set the **plugin.path configuration** option:

```
plugin.path=/opt/kafka/connector-plugins,/opt/connectors
```

The **plugin.path** configuration option can contain a comma-separated list of paths.

When running Kafka Connect in distributed mode, plug-ins must be made available on all worker nodes.

9.4. ADDING CONNECTOR PLUGINS

This procedure shows you how to add additional connector plug-ins.

Prerequisites

- An installed and running AMQ Streams cluster.

Procedure

1. Create the **/opt/kafka/connector-plugins** directory.

   ```
   su - kafka
   mkdir /opt/kafka/connector-plugins
   ```

2. Edit the **/opt/kafka/config/connect-standalone.properties** or **/opt/kafka/config/connect-distributed.properties** Kafka Connect configuration file, and set the **plugin.path** option to **/opt/kafka/connector-plugins**. For example:

   ```
   plugin.path=/opt/kafka/connector-plugins
   ```

3. Copy your connector plug-ins to **/opt/kafka/connector-plugins**.

4. Start or restart the Kafka Connect workers.

Additional resources

- For more information on installing AMQ Streams, see Section 2.3, “Installing AMQ Streams”.
- For more information on configuring AMQ Streams, see Section 2.8, “Configuring AMQ Streams”.
- For more information on running Kafka Connect in standalone mode, see Section 9.1.3, “Running Kafka Connect in standalone mode”.
- For more information on running Kafka Connect in distributed mode, see Section 9.2.3, “Running distributed Kafka Connect”.
- For a complete list of supported Kafka Connect configuration options, see Appendix F, *Kafka Connect configuration parameters*.

CHAPTER 10. USING AMQ STREAMS WITH MIRRORMAKER 2.0

MirrorMaker 2.0 is used to replicate data between two or more active Kafka clusters, within or across data centers.

Data replication across clusters supports scenarios that require:

- Recovery of data in the event of a system failure
- Aggregation of data for analysis
- Restriction of data access to a specific cluster
- Provision of data at a specific location to improve latency

NOTE

MirrorMaker 2.0 has features not supported by the previous version of MirrorMaker. However, you can configure MirrorMaker 2.0 to be used in legacy mode .

Additional resources

- Apache Kafka documentation
- Section 16.3.2, “Enabling tracing for MirrorMaker 2.0”

10.1. MIRRORMAKER 2.0 DATA REPLICATION

MirrorMaker 2.0 consumes messages from a source Kafka cluster and writes them to a target Kafka cluster.

MirrorMaker 2.0 uses:

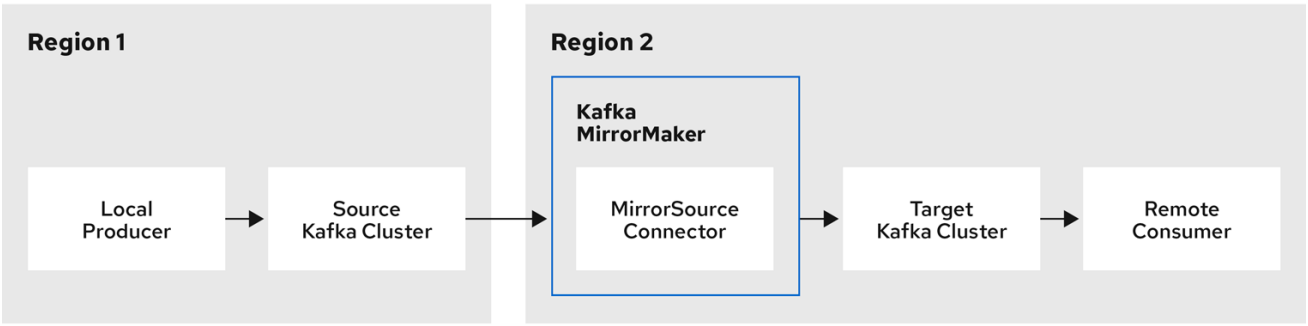
- Source cluster configuration to consume data from the source cluster
- Target cluster configuration to output data to the target cluster

MirrorMaker 2.0 is based on the Kafka Connect framework, *connectors* managing the transfer of data between clusters. A MirrorMaker 2.0 **MirrorSourceConnector** replicates topics from a source cluster to a target cluster.

The process of *mirroring* data from one cluster to another cluster is asynchronous. The recommended pattern is for messages to be produced locally alongside the source Kafka cluster, then consumed remotely close to the target Kafka cluster.

MirrorMaker 2.0 can be used with more than one source cluster.

Figure 10.1. Replication across two clusters



10.2. CLUSTER CONFIGURATION

You can use MirrorMaker 2.0 in *active/passive* or *active/active* cluster configurations.

- In an *active/active* configuration, both clusters are active and provide the same data simultaneously, which is useful if you want to make the same data available locally in different geographical locations.
- In an *active/passive* configuration, the data from an active cluster is replicated in a passive cluster, which remains on standby, for example, for data recovery in the event of system failure.

The expectation is that producers and consumers connect to active clusters only.

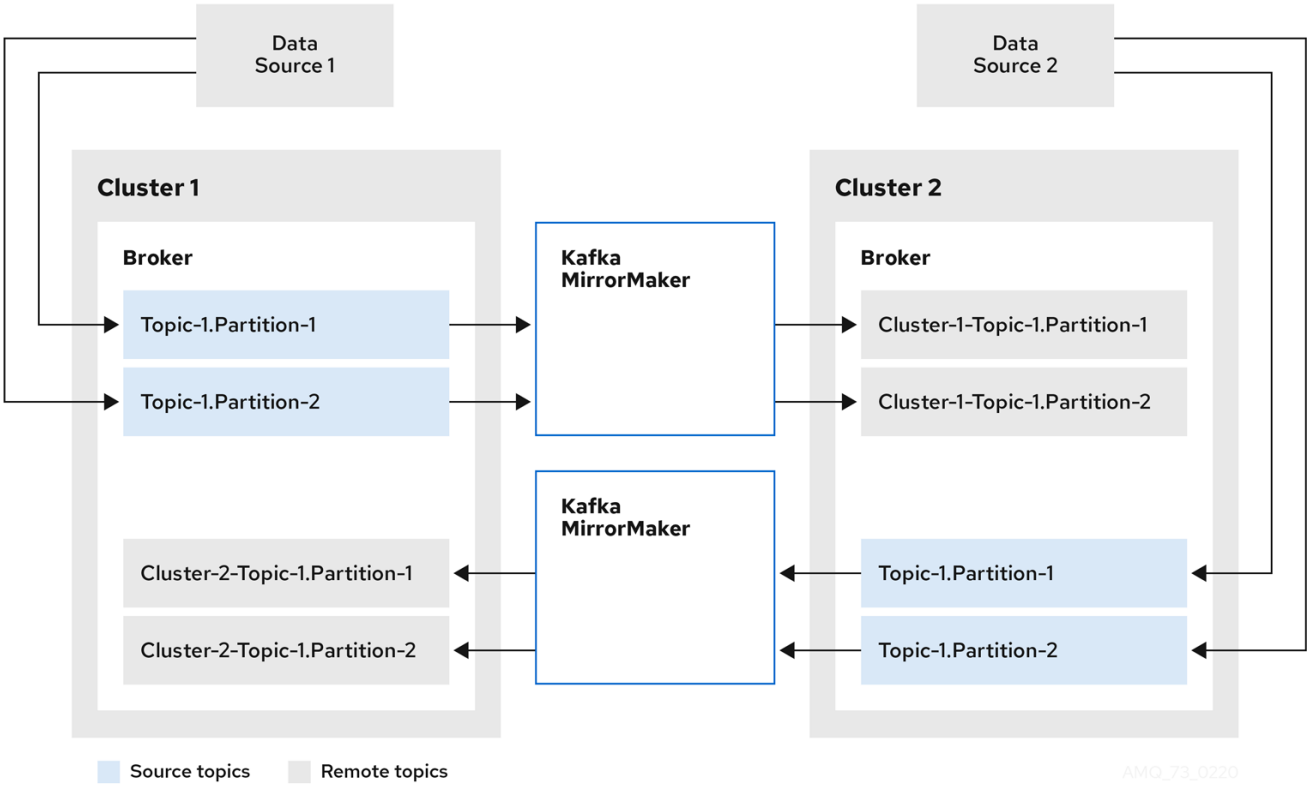
A MirrorMaker 2.0 cluster is required at each target destination.

10.2.1. Bidirectional replication (active/active)

The MirrorMaker 2.0 architecture supports bidirectional replication in an *active/active* cluster configuration.

Each cluster replicates the data of the other cluster using the concept of *source* and *remote* topics. As the same topics are stored in each cluster, remote topics are automatically renamed by MirrorMaker 2.0 to represent the source cluster. The name of the originating cluster is prepended to the name of the topic.

Figure 10.2. Topic renaming



By flagging the originating cluster, topics are not replicated back to that cluster.

The concept of replication through *remote* topics is useful when configuring an architecture that requires data aggregation. Consumers can subscribe to source and remote topics within the same cluster, without the need for a separate aggregation cluster.

10.2.2. Unidirectional replication (active/passive)

The MirrorMaker 2.0 architecture supports unidirectional replication in an *active/passive* cluster configuration.

You can use an *active/passive* cluster configuration to make backups or migrate data to another cluster. In this situation, you might not want automatic renaming of remote topics.

You can override automatic renaming by adding **IdentityReplicationPolicy** to the source connector configuration of the **KafkaMirrorMaker2** resource. With this configuration applied, topics retain their original names.

10.2.3. Topic configuration synchronization

Topic configuration is automatically synchronized between source and target clusters. By synchronizing configuration properties, the need for rebalancing is reduced.

10.2.4. Data integrity

MirrorMaker 2.0 monitors source topics and propagates any configuration changes to remote topics, checking for and creating missing partitions. Only MirrorMaker 2.0 can write to remote topics.

10.2.5. Offset tracking

MirrorMaker 2.0 tracks offsets for consumer groups using *internal topics*.

- The *offset sync* topic maps the source and target offsets for replicated topic partitions from record metadata
- The *checkpoint* topic maps the last committed offset in the source and target cluster for replicated topic partitions in each consumer group

Offsets for the *checkpoint* topic are tracked at predetermined intervals through configuration. Both topics enable replication to be fully restored from the correct offset position on failover.

MirrorMaker 2.0 uses its **MirrorCheckpointConnector** to emit *checkpoints* for offset tracking.

10.2.6. Connectivity checks

A *heartbeat* internal topic checks connectivity between clusters.

The *heartbeat* topic is replicated from the source cluster.

Target clusters use the topic to check:

- The connector managing connectivity between clusters is running
- The source cluster is available

MirrorMaker 2.0 uses its **MirrorHeartbeatConnector** to emit *heartbeats* that perform these checks.

10.3. ACL RULES SYNCHRONIZATION

If **AclAuthorizer** is being used, ACL rules that manage access to brokers also apply to remote topics. Users that can read a source topic can read its remote equivalent.

NOTE

OAuth 2.0 authorization does not support access to remote topics in this way.

10.4. SYNCHRONIZING DATA BETWEEN KAFKA CLUSTERS USING MIRRORMAKER 2.0

Use MirrorMaker 2.0 to synchronize data between Kafka clusters through configuration.

The previous version of MirrorMaker continues to be supported, by running MirrorMaker 2.0 in legacy mode.

The configuration must specify:

- Each Kafka cluster
- Connection information for each cluster, including TLS authentication
- The replication flow and direction
  - Cluster to cluster
  - Topic to topic

- Replication rules
- Committed offset tracking intervals

This procedure describes how to implement MirrorMaker 2.0 by creating the configuration in a properties file, then passing the properties when using the MirrorMaker script file to set up the connections.

NOTE

MirrorMaker 2.0 uses Kafka Connect to make the connections to transfer data between clusters. Kafka provides MirrorMaker sink and source connectors for data replication. If you wish to use the connectors instead of the MirrorMaker script, the connectors must be configured in the Kafka Connect cluster. For more information, refer to the Apache Kafka documentation.

Before you begin

A sample configuration properties file is provided in **./config/connect-mirror-maker.properties**.

Prerequisites

- You need AMQ Streams installed on the hosts of each Kafka cluster node you are replicating.

Procedure

1. Open the sample properties file in a text editor, or create a new one, and edit the file to include connection information and the replication flows for each Kafka cluster.
   The following example shows a configuration to connect two clusters, *cluster-1* and *cluster-2*, bidirectionally. Cluster names are configurable through the **clusters** property.

```
clusters=cluster-1,cluster-2 (1)

cluster-1.bootstrap.servers=<my-cluster>-kafka-bootstrap-<my-project>:443 (2)
cluster-1.security.protocol=SSL (3)
cluster-1.ssl.truststore.password=<my-truststore-password>
cluster-1.ssl.truststore.location=<path-to-truststore>/truststore.cluster-1.jks
cluster-1.ssl.keystore.password=<my-keystore-password>
cluster-1.ssl.keystore.location=<path-to-keystore>/user.cluster-1.p12

cluster-2.bootstrap.servers=<my-cluster>-kafka-bootstrap-<my-project>:443 (4)
cluster-2.security.protocol=SSL (5)
cluster-2.ssl.truststore.password=<my-truststore-password>
cluster-2.ssl.truststore.location=<path-to-truststore>/truststore.cluster-2.jks
cluster-2.ssl.keystore.password=<my-keystore-password>
cluster-2.ssl.keystore.location=<path-to-keystore>/user.cluster-2.p12

cluster-1->cluster-2.enabled=true (6)
cluster-1->cluster-2.topics=.* (7)
cluster-2->cluster-1.enabled=true (8)
cluster-2->cluster-1B->C.topics=.* (9)

replication.policy.separator=- (10)
```

```
sync.topic.acls.enabled=false 11
refresh.topics.interval.seconds=60 12
refresh.groups.interval.seconds=60 13
```

1. Each Kafka cluster is identified with its alias.
2. Connection information for *cluster-1*, using the *bootstrap address* and port *443*. Both clusters use port *443* to connect to Kafka using OpenShift *Routes*.
3. The **ssl.** properties define TLS configuration for *cluster-1*.
4. Connection information for *cluster-2*.
5. The **ssl.** properties define the TLS configuration for *cluster-2*.
6. Replication flow enabled from the *cluster-1* cluster to the *cluster-2* cluster.
7. Replicates all topics from the *cluster-1* cluster to the *cluster-2* cluster.
8. Replication flow enabled from the *cluster-2* cluster to the *cluster-1* cluster.
9. Replicates specific topics from the *cluster-2* cluster to the *cluster-1* cluster.
10. Defines the separator used for the renaming of remote topics.
11. When enabled, ACLs are applied to synchronized topics. The default is **false**.
12. The period between checks for new topics to synchronize.
13. The period between checks for new consumer groups to synchronize.

2. (Option) If required, add a policy that overrides the automatic renaming of remote topics. Instead of prepending the name with the name of the source cluster, the topic retains its original name.
   This optional setting is used for active/passive backups and data migration.

```
replication.policy.class=io.strimzi.kafka.connect.mirror.IdentityReplicationPolicy
```

3. Start ZooKeeper and Kafka in the target clusters:

```
su - kafka
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

```
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

4. Start MirrorMaker with the cluster connection configuration and replication policies you defined in your properties file:

```
/opt/kafka/bin/connect-mirror-maker.sh /config/connect-mirror-maker.properties
```

   MirrorMaker sets up connections between the clusters.

5. For each target cluster, verify that the topics are being replicated:

```
/bin/kafka-topics.sh --bootstrap-server <BrokerAddress> --list
```

10.5. USING MIRRORMAKER 2.0 IN LEGACY MODE

This procedure describes how to configure MirrorMaker 2.0 to use it in legacy mode. Legacy mode supports the previous version of MirrorMaker.

The MirrorMaker script **/opt/kafka/bin/kafka-mirror-maker.sh** can run MirrorMaker 2.0 in legacy mode.

Prerequisites

You need the properties files you currently use with the legacy version of MirrorMaker.

- **/opt/kafka/config/consumer.properties**
- **/opt/kafka/config/producer.properties**

Procedure

1. Edit the MirrorMaker **consumer.properties** and **producer.properties** files to turn off MirrorMaker 2.0 features.
   For example:

```
replication.policy.class=org.apache.kafka.mirror.LegacyReplicationPolicy (1)

refresh.topics.enabled=false (2)
refresh.groups.enabled=false
emit.checkpoints.enabled=false
emit.heartbeats.enabled=false
sync.topic.configs.enabled=false
sync.topic.acls.enabled=false
```

(1) Emulate the previous version of MirrorMaker.

(2) MirrorMaker 2.0 features disabled, including the internal *checkpoint* and *heartbeat* topics

2. Save the changes and restart MirrorMaker with the properties files you used with the previous version of MirrorMaker:

```
su - kafka /opt/kafka/bin/kafka-mirror-maker.sh \
--consumer.config /opt/kafka/config/consumer.properties \
--producer.config /opt/kafka/config/producer.properties \
--num.streams=2
```

   The **consumer** properties provide the configuration for the source cluster and the **producer** properties provide the target cluster configuration.

   MirrorMaker sets up connections between the clusters.

3. Start ZooKeeper and Kafka in the target cluster:

```
su - kafka
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
```

```
su - kafka
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

4. For the target cluster, verify that the topics are being replicated:

```
/bin/kafka-topics.sh --bootstrap-server <BrokerAddress> --list
```

CHAPTER 11. KAFKA CLIENTS

The **kafka-clients** JAR file contains the Kafka Producer and Consumer APIs together with the Kafka AdminClient API.

- The Producer API allows applications to send data to a Kafka broker.
- The Consumer API allows applications to consume data from a Kafka broker.
- The AdminClient API provides functionality for managing Kafka clusters, including topics, brokers, and other components.

11.1. ADDING KAFKA CLIENTS AS A DEPENDENCY TO YOUR MAVEN PROJECT

This procedure shows you how to add the AMQ Streams Java clients as a dependency to your Maven project.

Prerequisites

- A Maven project with an existing **pom.xml**.

Procedure

1. Add the Red Hat Maven repository to the **<repositories>** section of your **pom.xml** file.

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/xsd/maven-4.0.0.xsd">

    <!-- ... -->

    <repositories>
        <repository>
            <id>redhat-maven</id>
            <url>https://maven.repository.redhat.com/ga/</url>
        </repository>
    </repositories>

    <!-- ... -->

</project>
```

2. Add the clients to the **<dependencies>** section of your **pom.xml** file.

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/xsd/maven-4.0.0.xsd">

    <!-- ... -->
```

```
    <dependencies>
        <dependency>
            <groupId>org.apache.kafka</groupId>
            <artifactId>kafka-clients</artifactId>
            <version>2.6.0.redhat-00004</version>
        </dependency>
    </dependencies>

    <!-- ... -->
</project>
```

3. Build your Maven project.

CHAPTER 12. KAFKA STREAMS API OVERVIEW

The Kafka Streams API allows applications to receive data from one or more input streams, execute complex operations like mapping, filtering or joining, and write the results into one or more output streams. It is part of the **kafka-streams** JAR package that is available in the Red Hat Maven repository.

12.1. ADDING THE KAFKA STREAMS API AS A DEPENDENCY TO YOUR MAVEN PROJECT

This procedure shows you how to add the AMQ Streams Java clients as a dependency to your Maven project.

Prerequisites

- A Maven project with an existing **pom.xml**.

Procedure

1. Add the Red Hat Maven repository to the **<repositories>** section of your **pom.xml** file.

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/xsd/maven-4.0.0.xsd">

    <!-- ... -->

    <repositories>
        <repository>
            <id>redhat-maven</id>
            <url>https://maven.repository.redhat.com/ga/</url>
        </repository>
    </repositories>

    <!-- ... -->

</project>
```

2. Add **kafka-streams** to the **<dependencies>** section of your **pom.xml** file.

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/xsd/maven-4.0.0.xsd">

    <!-- ... -->

    <dependencies>
        <dependency>
            <groupId>org.apache.kafka</groupId>
            <artifactId>kafka-streams</artifactId>
            <version>2.6.0.redhat-00004</version>
```

```
        </dependency>
    </dependencies>

    <!-- ... -->
</project>
```

3. Build your Maven project.

CHAPTER 13. KAFKA BRIDGE

This chapter provides an overview of the AMQ Streams Kafka Bridge on Red Hat Enterprise Linux and helps you get started using its REST API to interact with AMQ Streams. To try out the Kafka Bridge in your local environment, see the Section 13.2, "Kafka Bridge quickstart" later in this chapter.

Additional resources

- To view the API documentation, including example requests and responses, see the Kafka Bridge API reference.
- To configure the Kafka Bridge for distributed tracing, see Section 16.4, "Enabling tracing for the Kafka Bridge".

13.1. KAFKA BRIDGE OVERVIEW

The Kafka Bridge provides a RESTful interface that allows HTTP-based clients to interact with a Kafka cluster. It offers the advantages of a web API connection to AMQ Streams, without the need for client applications to interpret the Kafka protocol.

The API has two main resources--**consumers** and **topics**--that are exposed and made accessible through endpoints to interact with consumers and producers in your Kafka cluster. The resources relate only to the Kafka Bridge, not the consumers and producers connected directly to Kafka.

HTTP requests

The Kafka Bridge supports HTTP requests to a Kafka cluster, with methods to:

- Send messages to a topic.
- Retrieve messages from topics.
- Retrieve a list of partitions for a topic.
- Create and delete consumers.
- Subscribe consumers to topics, so that they start receiving messages from those topics.
- Retrieve a list of topics that a consumer is subscribed to.
- Unsubscribe consumers from topics.
- Assign partitions to consumers.
- Commit a list of consumer offsets.
- Seek on a partition, so that a consumer starts receiving messages from the first or last offset position, or a given offset position.

The methods provide JSON responses and HTTP response code error handling. Messages can be sent in JSON or binary formats.

Clients can produce and consume messages without the requirement to use the native Kafka protocol.

Similar to an AMQ Streams installation, you can download the Kafka Bridge files for installation on Red Hat Enterprise Linux. See Section 13.1.5, "Downloading a Kafka Bridge archive" .

For more information on configuring the host and port for the **KafkaBridge** resource, see Section 13.1.6, "Configuring Kafka Bridge properties".

13.1.1. Authentication and encryption

Authentication and encryption between HTTP clients and the Kafka Bridge is not yet supported. This means that requests sent from clients to the Kafka Bridge are:

- Not encrypted, and must use HTTP rather than HTTPS
- Sent without authentication

You can configure TLS or SASL-based authentication between the Kafka Bridge and your Kafka cluster.

You configure the Kafka Bridge for authentication through its properties file.

13.1.2. Requests to the Kafka Bridge

Specify data formats and HTTP headers to ensure valid requests are submitted to the Kafka Bridge.

API request and response bodies are always encoded as JSON.

13.1.2.1. Content Type headers

A **Content-Type** header must be submitted for all requests. The only exception is when the **POST** request body is empty, where adding a **Content-Type** header will cause the request to fail.

Consumer operations (/**consumers** endpoints) and producer operations (/**topics** endpoints) require different **Content-Type** headers.

Content-Type headers for consumer operations

Regardless of the embedded data format, **POST** requests for consumer operations must provide the following **Content-Type** header if the request body contains data:

```
Content-Type: application/vnd.kafka.v2+json
```

Content-Type headers for producer operations

When performing producer operations, **POST** requests must provide **Content-Type** headers specifying the *embedded data format* of the messages produced. This can be either **json** or **binary**.

Table 13.1. Content-Type headers for data formats

Embedded data format	Content-Type header
JSON	**Content-Type: application/vnd.kafka.json.v2+json**
Binary	**Content-Type: application/vnd.kafka.binary.v2+json**

The embedded data format is set per consumer, as described in the next section.

The **Content-Type** must *not* be set if the **POST** request has an empty body. An empty body can be used to create a consumer with the default values.

13.1.2.2. Embedded data format

The embedded data format is the format of the Kafka messages that are transmitted, over HTTP, from a producer to a consumer using the Kafka Bridge. Two embedded data formats are supported: JSON or binary.

When creating a consumer using the **/consumers/groupid** endpoint, the **POST** request body must specify an embedded data format of either JSON or binary. This is specified in the **format** field in the request body, for example:

```
{
  "name": "my-consumer",
  "format": "binary", (1)
...
}
```

(1) A binary embedded data format.

If an embedded data format for the consumer is not specified, then a binary format is set.

The embedded data format specified when creating a consumer must match the data format of the Kafka messages it will consume.

If you choose to specify a binary embedded data format, subsequent producer requests must provide the binary data in the request body as Base64-encoded strings. For example, when sending messages by making **POST** requests to the **/topics/*topicname*** endpoint, the **value** must be encoded in Base64:

```
{
  "records": [
    {
      "key": "my-key",
      "value": "ZWR3YXJkdGhldGhyZWVsZWdnZWRjYXQ="
    },
  ]
}
```

Producer requests must also provide a **Content-Type** header that corresponds to the embedded data format, for example, **Content-Type: application/vnd.kafka.binary.v2+json**.

13.1.2.3. Message format

When sending messages using the **/topics** endpoint, you enter the message payload in the request body, in the **records** parameter.

The **records** parameter can contain any of these optional fields:

- Message **key**
- Message **value**
- Destination **partition**

- Message **headers**

Example POST request to /topics

```
curl -X POST \
  http://localhost:8080/topics/my-topic \
  -H 'content-type: application/vnd.kafka.json.v2+json' \
  -d '{
    "records": [
        {
            "key": "my-key",
            "value": "sales-lead-0001"
            "partition": 2
            "headers": [
              {
                "key": "key1",
                "value": "QXBhY2hlIEthZmthIGlzIHRoZSBib21iIQ==" (1)
              }
            ]
        },
    ]
}'
```

(1) The header value in binary format and encoded as Base64.

13.1.2.4. Accept headers

After creating a consumer, all subsequent GET requests must provide an **Accept** header in the following format:

```
Accept: application/vnd.kafka.embedded-data-format.v2+json
```

The *embedded-data-format* is either **json** or **binary**.

For example, when retrieving records for a subscribed consumer using an embedded data format of JSON, include this Accept header:

```
Accept: application/vnd.kafka.json.v2+json
```

13.1.3. Configuring loggers for the Kafka Bridge

The AMQ Streams Kafka bridge allows you to set a different log level for each operation that is defined by the related OpenAPI specification.

Each operation has a corresponding API endpoint through which the bridge receives requests from HTTP clients. You can change the log level on each endpoint to produce more or less fine-grained logging information about the incoming and outgoing HTTP requests.

Loggers are defined in the **log4j.properties** file, which has the following default configuration for **healthy** and **ready** endpoints:

```
log4j.logger.http.openapi.operation.healthy=WARN, out
log4j.additivity.http.openapi.operation.healthy=false
```

```
log4j.logger.http.openapi.operation.ready=WARN, out
log4j.additivity.http.openapi.operation.ready=false
```

The log level of all other operations is set to **INFO** by default. Loggers are formatted as follows:

```
log4j.logger.http.openapi.operation.<operation-id>
```

Where **<operation-id>** is the identifier of the specific operation. Following is the list of operations defined by the OpenAPI specification:

- **createConsumer**
- **deleteConsumer**
- **subscribe**
- **unsubscribe**
- **poll**
- **assign**
- **commit**
- **send**
- **sendToPartition**
- **seekToBeginning**
- **seekToEnd**
- **seek**
- **healthy**
- **ready**
- **openapi**

13.1.4. Kafka Bridge API resources

For the full list of REST API endpoints and descriptions, including example requests and responses, see the Kafka Bridge API reference .

13.1.5. Downloading a Kafka Bridge archive

A zipped distribution of the AMQ Streams Kafka Bridge is available for download from the Red Hat website.

Procedure

- Download the latest version of the Red Hat AMQ Streams Kafka Bridge archive from the Customer Portal.

13.1.6. Configuring Kafka Bridge properties

This procedure describes how to configure the Kafka and HTTP connection properties used by the AMQ Streams Kafka Bridge.

You configure the Kafka Bridge, as any other Kafka client, using appropriate prefixes for Kafka-related properties.

- **kafka.** for general configuration that applies to producers and consumers, such as server connection and security.
- **kafka.consumer.** for consumer-specific configuration passed only to the consumer.
- **kafka.producer.** for producer-specific configuration passed only to the producer.

As well as enabling HTTP access to a Kafka cluster, HTTP properties provide the capability to enable and define access control for the Kafka Bridge through Cross-Origin Resource Sharing (CORS). CORS is a HTTP mechanism that allows browser access to selected resources from more than one origin. To configure CORS, you define a list of allowed resource origins and HTTP methods to access them. Additional HTTP headers in requests describe the origins that are permitted access to the Kafka cluster .

Prerequisites

- AMQ Streams is installed on the host
- The Kafka Bridge installation archive is downloaded

Procedure

1. Edit the **application.properties** file provided with the AMQ Streams Kafka Bridge installation archive.
   Use the properties file to specify Kafka and HTTP-related properties, and to enable distributed tracing.

   a. Configure standard Kafka-related properties, including properties specific to the Kafka consumers and producers.
      Use:

      - **kafka.bootstrap.servers** to define the host/port connections to the Kafka cluster
      - **kafka.producer.acks** to provide acknowledgments to the HTTP client
      - **kafka.consumer.auto.offset.reset** to determine how to manage reset of the offset in Kafka
        For more information on configuration of Kafka properties, see the Apache Kafka website

   b. Configure HTTP-related properties to enable HTTP access to the Kafka cluster.
      For example:

```
http.enabled=true
http.host=0.0.0.0
http.port=8080 1
```

```
http.cors.enabled=true (2)
http.cors.allowedOrigins=https://strimzi.io (3)
http.cors.allowedMethods=GET,POST,PUT,DELETE,OPTIONS,PATCH (4)
```

1. The default HTTP configuration for the Kafka Bridge to listen on port 8080.
2. Set to **true** to enable CORS.
3. Comma-separated list of allowed CORS origins. You can use a URL or a Java regular expression.
4. Comma-separated list of allowed HTTP methods for CORS.

c. Enable or disable distributed tracing.

```
bridge.tracing=jaeger
```

Remove code comments from the property to enable distributed tracing

Additional resources

- Chapter 16, *Distributed tracing*
- Section 16.4, "Enabling tracing for the Kafka Bridge"

13.1.7. Installing the Kafka Bridge

Follow this procedure to install the AMQ Streams Kafka Bridge on Red Hat Enterprise Linux.

Prerequisites

- AMQ Streams is installed on the host
- The Kafka Bridge installation archive is downloaded
- The Kafka Bridge configuration properties are set

Procedure

1. If you have not already done so, unzip the AMQ Streams Kafka Bridge installation archive to any directory.
2. Run the Kafka Bridge script using the configuration properties as a parameter:
   For example:

```
./bin/kafka_bridge_run.sh --config-file=_path_/configfile.properties
```

3. Check to see that the installation was successful in the log.

```
HTTP-Kafka Bridge started and listening on port 8080
HTTP-Kafka Bridge bootstrap servers localhost:9092
```

13.2. KAFKA BRIDGE QUICKSTART

Use this quickstart to try out the AMQ Streams Kafka Bridge on Red Hat Enterprise Linux. You will learn how to:

- Install the Kafka Bridge
- Produce messages to topics and partitions in your Kafka cluster
- Create a Kafka Bridge consumer
- Perform basic consumer operations, such as subscribing the consumer to topics and retrieving the messages that you produced

In this quickstart, HTTP requests are formatted as curl commands that you can copy and paste to your terminal.

Ensure you have the prerequisites and then follow the tasks in the order provided in this chapter.

About data formats

In this quickstart, you will produce and consume messages in JSON format, not binary. For more information on the data formats and HTTP headers used in the example requests, see Section 13.1.1, “Authentication and encryption”.

Prerequisites for the quickstart

- AMQ Streams is installed on the host
- A single node AMQ Streams cluster is running
- The Kafka Bridge installation archive is downloaded

13.2.1. Deploying the Kafka Bridge locally

Deploy an instance of the AMQ Streams Kafka Bridge to the host. Use the **application.properties** file provided with the installation archive to apply the default configuration settings.

Procedure

1. Open the **application.properties** file and check that the default **HTTP related settings** are defined:

```
http.enabled=true
http.host=0.0.0.0
http.port=8080
```

   This configures the Kafka Bridge to listen for requests on port 8080.

2. Run the Kafka Bridge script using the configuration properties as a parameter:

```
./bin/kafka_bridge_run.sh --config-file=<path>/application.properties
```

What to do next

- Produce messages to topics and partitions .

13.2.2. Producing messages to topics and partitions

Produce messages to a topic in JSON format by using the topics endpoint.

You can specify destination partitions for messages in the request body, as shown below. The partitions endpoint provides an alternative method for specifying a single destination partition for all messages as a path parameter.

Procedure

1. Create a Kafka topic using the **kafka-topics.sh** utility:

```
bin/kafka-topics.sh --bootstrap-server localhost:9092 --create --topic bridge-quickstart-topic --partitions 3 --replication-factor 1 --config retention.ms=7200000 --config segment.bytes=1073741824
```

   Specify three partitions.

2. Verify that the topic was created:

```
bin/kafka-topics.sh --bootstrap-server localhost:9092 --describe --topic bridge-quickstart-topic
```

3. Using the Kafka Bridge, produce three messages to the topic you created:

```
curl -X POST \
  http://localhost:8080/topics/bridge-quickstart-topic \
  -H 'content-type: application/vnd.kafka.json.v2+json' \
  -d '{
    "records": [
        {
            "key": "my-key",
            "value": "sales-lead-0001"
        },
        {
            "value": "sales-lead-0002",
            "partition": 2
        },
        {
            "value": "sales-lead-0003"
        }
    ]
}'
```

   - **sales-lead-0001** is sent to a partition based on the hash of the key.
   - **sales-lead-0002** is sent directly to partition 2.
   - **sales-lead-0003** is sent to a partition in the **bridge-quickstart-topic** topic using a round-robin method.

4. If the request is successful, the Kafka Bridge returns an **offsets** array, along with a **200** (OK) code and a **content-type** header of **application/vnd.kafka.v2+json**. For each message, the **offsets** array describes:

   - The partition that the message was sent to
   - The current message offset of the partition

   Example response

```
#...
{
  "offsets":[
    {
      "partition":0,
      "offset":0
    },
    {
      "partition":2,
      "offset":0
    },
    {
      "partition":0,
      "offset":1
    }
  ]
}
```

What to do next

After producing messages to topics and partitions, create a Kafka Bridge consumer .

Additional resources

- POST /topics/{topicname} in the API reference documentation.
- POST /topics/{topicname}/partitions/{partitionid} in the API reference documentation.

13.2.3. Creating a Kafka Bridge consumer

Before you can perform any consumer operations on the Kafka cluster, you must first create a consumer by using the consumers endpoint. The consumer is referred to as a *Kafka Bridge consumer*.

Procedure

1. Create a Kafka Bridge consumer in a new consumer group named **bridge-quickstart-consumer-group**:

```
curl -X POST http://localhost:8080/consumers/bridge-quickstart-consumer-group \
  -H 'content-type: application/vnd.kafka.v2+json' \
  -d '{
    "name": "bridge-quickstart-consumer",
    "auto.offset.reset": "earliest",
    "format": "json",
    "enable.auto.commit": false,
```

```
  "fetch.min.bytes": 512,
  "consumer.request.timeout.ms": 30000
}'
```

- The consumer is named **bridge-quickstart-consumer** and the embedded data format is set as **json**.
- The consumer will not commit offsets to the log automatically because the **enable.auto.commit** setting is **false**. You will commit the offsets manually later in this quickstart.

NOTE

The Kafka Bridge generates a random consumer name if you do not specify a consumer name in the request body.

If the request is successful, the Kafka Bridge returns the consumer ID (**instance_id**) and base URL (**base_uri**) in the response body, along with a **200** (OK) code.

Example response

```
#...
{
  "instance_id": "bridge-quickstart-consumer",
  "base_uri":"http://<bridge-name>-bridge-service:8080/consumers/bridge-quickstart-consumer-group/instances/bridge-quickstart-consumer"
}
```

2. Copy the base URL (**base_uri**) to use in the other consumer operations in this quickstart.

What to do next

Now that you have created a Kafka Bridge consumer, you can subscribe it to topics .

Additional resources

- POST /consumers/{groupid} in the API reference documentation.

13.2.4. Subscribing a Kafka Bridge consumer to topics

Subscribe the Kafka Bridge consumer to one or more topics by using the subscription endpoint. Once subscribed, the consumer starts receiving all messages that are produced to the topic.

Procedure

- Subscribe the consumer to the **bridge-quickstart-topic** topic that you created earlier, in Producing messages to topics and partitions :

```
curl -X POST http://localhost:8080/consumers/bridge-quickstart-consumer-group/instances/bridge-quickstart-consumer/subscription \
  -H 'content-type: application/vnd.kafka.v2+json' \
  -d '{
    "topics": [
```

```
        "bridge-quickstart-topic"
    ]
}'
```

The **topics** array can contain a single topic (as shown above) or multiple topics. If you want to subscribe the consumer to multiple topics that match a regular expression, you can use the **topic_pattern** string instead of the **topics** array.

If the request is successful, the Kafka Bridge returns a **204 No Content** code only.

What to do next

After subscribing a Kafka Bridge consumer to topics, you can retrieve messages from the consumer.

Additional resources

- POST /consumers/{groupid}/instances/{name}/subscription in the API reference documentation.

13.2.5. Retrieving the latest messages from a Kafka Bridge consumer

Retrieve the latest messages from the Kafka Bridge consumer by requesting data from the records endpoint. In production, HTTP clients can call this endpoint repeatedly (in a loop).

Procedure

1. Produce additional messages to the Kafka Bridge consumer, as described in Producing messages to topics and partitions.
2. Submit a **GET** request to the **records** endpoint:

```
curl -X GET http://localhost:8080/consumers/bridge-quickstart-consumer-group/instances/bridge-quickstart-consumer/records \
  -H 'accept: application/vnd.kafka.json.v2+json'
```

After creating and subscribing to a Kafka Bridge consumer, a first GET request will return an empty response because the poll operation triggers a rebalancing process to assign partitions.

3. Repeat step two to retrieve messages from the Kafka Bridge consumer.
The Kafka Bridge returns an array of messages – describing the topic name, key, value, partition, and offset – in the response body, along with a **200** (OK) code. Messages are retrieved from the latest offset by default.

```
HTTP/1.1 200 OK
content-type: application/vnd.kafka.json.v2+json
#...
[
  {
    "topic":"bridge-quickstart-topic",
    "key":"my-key",
    "value":"sales-lead-0001",
    "partition":0,
    "offset":0
  },
  {
```

```
    "topic":"bridge-quickstart-topic",
    "key":null,
    "value":"sales-lead-0003",
    "partition":0,
    "offset":1
  },
#...
```

NOTE

If an empty response is returned, produce more records to the consumer as described in Producing messages to topics and partitions , and then try retrieving messages again.

What to do next

After retrieving messages from a Kafka Bridge consumer, try committing offsets to the log .

Additional resources

- GET /consumers/{groupid}/instances/{name}/records in the API reference documentation.

13.2.6. Commiting offsets to the log

Use the offsets endpoint to manually commit offsets to the log for all messages received by the Kafka Bridge consumer. This is required because the Kafka Bridge consumer that you created earlier, in Creating a Kafka Bridge consumer , was configured with the **enable.auto.commit** setting as **false**.

Procedure

- Commit offsets to the log for the **bridge-quickstart-consumer**:

```
curl -X POST http://localhost:8080/consumers/bridge-quickstart-consumer-
group/instances/bridge-quickstart-consumer/offsets
```

Because no request body is submitted, offsets are committed for all the records that have been received by the consumer. Alternatively, the request body can contain an array (OffsetCommitSeekList) that specifies the topics and partitions that you want to commit offsets for.

If the request is successful, the Kafka Bridge returns a **204 No Content** code only.

What to do next

After committing offsets to the log, try out the endpoints for seeking to offsets.

Additional resources

- POST /consumers/{groupid}/instances/{name}/offsets in the API reference documentation.

13.2.7. Seeking to offsets for a partition

Use the positions endpoints to configure the Kafka Bridge consumer to retrieve messages for a partition from a specific offset, and then from the latest offset. This is referred to in Apache Kafka as a seek operation.

Procedure

1. Seek to a specific offset for partition 0 of the **quickstart-bridge-topic** topic:

```
curl -X POST http://localhost:8080/consumers/bridge-quickstart-consumer-group/instances/bridge-quickstart-consumer/positions \
  -H 'content-type: application/vnd.kafka.v2+json' \
  -d '{
    "offsets": [
        {
            "topic": "bridge-quickstart-topic",
            "partition": 0,
            "offset": 2
        }
    ]
}'
```

   If the request is successful, the Kafka Bridge returns a **204 No Content** code only.

2. Submit a **GET** request to the **records** endpoint:

```
curl -X GET http://localhost:8080/consumers/bridge-quickstart-consumer-group/instances/bridge-quickstart-consumer/records \
  -H 'accept: application/vnd.kafka.json.v2+json'
```

   The Kafka Bridge returns messages from the offset that you seeked to.

3. Restore the default message retrieval behavior by seeking to the last offset for the same partition. This time, use the positions/end endpoint.

```
curl -X POST http://localhost:8080/consumers/bridge-quickstart-consumer-group/instances/bridge-quickstart-consumer/positions/end \
  -H 'content-type: application/vnd.kafka.v2+json' \
  -d '{
    "partitions": [
        {
            "topic": "bridge-quickstart-topic",
            "partition": 0
        }
    ]
}'
```

   If the request is successful, the Kafka Bridge returns another **204 No Content** code.

NOTE

You can also use the positions/beginning endpoint to seek to the first offset for one or more partitions.

What to do next

In this quickstart, you have used the AMQ Streams Kafka Bridge to perform several common operations on a Kafka cluster. You can now delete the Kafka Bridge consumer that you created earlier.

Additional resources

- POST /consumers/{groupid}/instances/{name}/positions in the API reference documentation.
- POST /consumers/{groupid}/instances/{name}/positions/beginning in the API reference documentation.
- POST /consumers/{groupid}/instances/{name}/positions/end in the API reference documentation.

13.2.8. Deleting a Kafka Bridge consumer

Finally, delete the Kafa Bridge consumer that you used throughout this quickstart.

Procedure

- Delete the Kafka Bridge consumer by sending a **DELETE** request to the instances endpoint.

```
curl -X DELETE http://localhost:8080/consumers/bridge-quickstart-consumer-group/instances/bridge-quickstart-consumer
```

  If the request is successful, the Kafka Bridge returns a **204 No Content** code only.

Additional resources

- DELETE /consumers/{groupid}/instances/{name} in the API reference documentation.

CHAPTER 14. USING KERBEROS (GSSAPI) AUTHENTICATION

AMQ Streams supports the use of the Kerberos (GSSAPI) authentication protocol for secure single sign-on access to your Kafka cluster. GSSAPI is an API wrapper for Kerberos functionality, insulating applications from underlying implementation changes.

Kerberos is a network authentication system that allows clients and servers to authenticate to each other by using symmetric encryption and a trusted third party, the Kerberos Key Distribution Centre (KDC).

14.1. SETTING UP AMQ STREAMS TO USE KERBEROS (GSSAPI) AUTHENTICATION

This procedure shows how to configure AMQ Streams so that Kafka clients can access Kafka and ZooKeeper using Kerberos (GSSAPI) authentication.

The procedure assumes that a Kerberos *krb5* resource server has been set up on a Red Hat Enterprise Linux host.

The procedure shows, with examples, how to configure:

1. Service principals
2. Kafka brokers to use the Kerberos login
3. ZooKeeper to use Kerberos login
4. Producer and consumer clients to access Kafka using Kerberos authentication

The instructions describe Kerberos set up for a single ZooKeeper and Kafka installation on a single host, with additional configuration for a producer and consumer client.

Prerequisites

To be able to configure Kafka and ZooKeeper to authenticate and authorize Kerberos credentials, you will need:

- Access to a Kerberos server
- A Kerberos client on each Kafka broker host

For more information on the steps to set up a Kerberos server, and clients on broker hosts, see the example Kerberos on RHEL set up configuration .

How you deploy Kerberos depends on your operating system. Red Hat recommends using Identity Management (IdM) when setting up Kerberos on Red Hat Enterprise Linux. Users of an Oracle or IBM JDK must install a Java Cryptography Extension (JCE).

- Oracle JCE
- IBM JCE

Add service principals for authentication

From your Kerberos server, create service principals (users) for ZooKeeper, Kafka brokers, and Kafka producer and consumer clients.

Service principals must take the form *SERVICE-NAME/FULLY-QUALIFIED-HOST-NAME@DOMAIN-REALM*.

1. Create the service principals, and keytabs that store the principal keys, through the Kerberos KDC.
   For example:

   - **zookeeper/node1.example.redhat.com@EXAMPLE.REDHAT.COM**
   - **kafka/node1.example.redhat.com@EXAMPLE.REDHAT.COM**
   - **producer1/node1.example.redhat.com@EXAMPLE.REDHAT.COM**
   - **consumer1/node1.example.redhat.com@EXAMPLE.REDHAT.COM**
     The ZooKeeper service principal must have the same hostname as the **zookeeper.connect** configuration in the Kafka **config/server.properties** file:

     ```
     zookeeper.connect=node1.example.redhat.com:2181
     ```

     If the hostname is not the same, *localhost* is used and authentication will fail.

2. Create a directory on the host and add the keytab files:
   For example:

   ```
   /opt/kafka/krb5/zookeeper-node1.keytab
   /opt/kafka/krb5/kafka-node1.keytab
   /opt/kafka/krb5/kafka-producer1.keytab
   /opt/kafka/krb5/kafka-consumer1.keytab
   ```

3. Ensure the **kafka** user can access the directory:

   ```
   chown kafka:kafka -R /opt/kafka/krb5
   ```

Configure ZooKeeper to use a Kerberos Login

Configure ZooKeeper to use the Kerberos Key Distribution Center (KDC) for authentication using the user principals and keytabs previously created for **zookeeper**.

1. Create or modify the **opt/kafka/config/jaas.conf** file to support ZooKeeper client and server operations:

   ```
   Client {
       com.sun.security.auth.module.Krb5LoginModule required debug=true
       useKeyTab=true (1)
       storeKey=true (2)
       useTicketCache=false (3)
       keyTab="/opt/kafka/krb5/zookeeper-node1.keytab" (4)
       principal="zookeeper/node1.example.redhat.com@EXAMPLE.REDHAT.COM"; (5)
   };

   Server {
       com.sun.security.auth.module.Krb5LoginModule required debug=true
       useKeyTab=true
       storeKey=true
       useTicketCache=false
   ```

```
    keyTab="/opt/kafka/krb5/zookeeper-node1.keytab"
    principal="zookeeper/node1.example.redhat.com@EXAMPLE.REDHAT.COM";
};

QuorumServer {
    com.sun.security.auth.module.Krb5LoginModule required debug=true
    useKeyTab=true
    storeKey=true
    keyTab="/opt/kafka/krb5/zookeeper-node1.keytab"
    principal="zookeeper/node1.example.redhat.com@EXAMPLE.REDHAT.COM";
};

QuorumLearner {
    com.sun.security.auth.module.Krb5LoginModule required debug=true
    useKeyTab=true
    storeKey=true
    keyTab="/opt/kafka/krb5/zookeeper-node1.keytab"
    principal="zookeeper/node1.example.redhat.com@EXAMPLE.REDHAT.COM";
};
```

1. Set to **true** to get the principal key from the keytab.
2. Set to **true** to store the principal key.
3. Set to **true** to obtain the Ticket Granting Ticket (TGT) from the ticket cache.
4. The **keyTab** property points to the location of the keytab file copied from the Kerberos KDC. The location and file must be readable by the **kafka** user.
5. The **principal** property is configured to match the fully-qualified principal name created on the KDC host, which follows the format ***SERVICE-NAME/FULLY-QUALIFIED-HOST-NAME@DOMAIN-NAME***.

2. Edit **opt/kafka/config/zookeeper.properties** to use the updated JAAS configuration:

```
# ...

requireClientAuthScheme=sasl
jaasLoginRenew=3600000 1
kerberos.removeHostFromPrincipal=false 2
kerberos.removeRealmFromPrincipal=false 3
quorum.auth.enableSasl=true 4
quorum.auth.learnerRequireSasl=true 5
quorum.auth.serverRequireSasl=true
quorum.auth.learner.loginContext=QuorumLearner 6
quorum.auth.server.loginContext=QuorumServer
quorum.auth.kerberos.servicePrincipal=zookeeper/_HOST 7
quorum.cnxn.threads.size=20
```

1. Controls the frequency for login renewal in milliseconds, which can be adjusted to suit ticket renewal intervals. Default is one hour.
2. Dictates whether the hostname is used as part of the login principal name. If using a single keytab for all nodes in the cluster, this is set to **true**. However, it is recommended to generate a separate keytab and fully-qualified principal for each broker host for

troubleshooting.

3. Controls whether the realm name is stripped from the principal name for Kerberos negotiations. It is recommended that this setting is set as **false**.

4. Enables SASL authentication mechanisms for the ZooKeeper server and client.

5. The **RequireSasl** properties controls whether SASL authentication is required for quorum events, such as master elections.

6. The **loginContext** properties identify the name of the login context in the JAAS configuration used for authentication configuration of the specified component. The loginContext names correspond to the names of the relevant sections in the **opt/kafka/config/jaas.conf** file.

7. Controls the naming convention to be used to form the principal name used for identification. The placeholder **_HOST** is automatically resolved to the hostnames defined by the **server.1** properties at runtime.

3. Start ZooKeeper with JVM parameters to specify the Kerberos login configuration:

```
su - kafka
export EXTRA_ARGS="-Djava.security.krb5.conf=/etc/krb5.conf -
Djava.security.auth.login.config=/opt/kafka/config/jaas.conf"; /opt/kafka/bin/zookeeper-server-
start.sh -daemon /opt/kafka/config/zookeeper.properties
```

If you are not using the default service name (**zookeeper**), add the name using the **-Dzookeeper.sasl.client.username=*NAME*** parameter.

NOTE

If you are using the **/etc/krb5.conf** location, you do not need to specify **-Djava.security.krb5.conf=/etc/krb5.conf** when starting ZooKeeper, Kafka, or the Kafka producer and consumer.

Configure the Kafka broker server to use a Kerberos login

Configure Kafka to use the Kerberos Key Distribution Center (KDC) for authentication using the user principals and keytabs previously created for **kafka**.

1. Modify the **opt/kafka/config/jaas.conf** file with the following elements:

```
KafkaServer {
    com.sun.security.auth.module.Krb5LoginModule required
    useKeyTab=true
    storeKey=true
    keyTab="/opt/kafka/krb5/kafka-node1.keytab"
    principal="kafka/node1.example.redhat.com@EXAMPLE.REDHAT.COM";
};
KafkaClient {
    com.sun.security.auth.module.Krb5LoginModule required debug=true
    useKeyTab=true
    storeKey=true
    useTicketCache=false
```

```
    keyTab="/opt/kafka/krb5/kafka-node1.keytab"
    principal="kafka/node1.example.redhat.com@EXAMPLE.REDHAT.COM";
};
```

2. Configure each broker in the Kafka cluster by modifying the listener configuration in the **config/server.properties** file so the listeners use the SASL/GSSAPI login.
Add the SASL protocol to the map of security protocols for the listener, and remove any unwanted protocols.

   For example:

```
# ...
broker.id=0
# ...
listeners=SECURE://:9092,REPLICATION://:9094 (1)
inter.broker.listener.name=REPLICATION
# ...
listener.security.protocol.map=SECURE:SASL_PLAINTEXT,REPLICATION:SASL_PLAINTEX
T (2)
# ..
sasl.enabled.mechanisms=GSSAPI (3)
sasl.mechanism.inter.broker.protocol=GSSAPI (4)
sasl.kerberos.service.name=kafka (5)
...
```

   (1) Two listeners are configured: a secure listener for general-purpose communications with clients (supporting TLS for communications), and a replication listener for inter-broker communications.

   (2) For TLS-enabled listeners, the protocol name is SASL_PLAINTEXT. For non-TLS-enabled connectors, the protocol name is SASL_PLAINTEXT. If SSL is not required, you can remove the **ssl.*** properties.

   (3) SASL mechanism for Kerberos authentication is **GSSAPI**.

   (4) Kerberos authentication for inter-broker communication.

   (5) The name of the service used for authentication requests is specified to distinguish it from other services that may also be using the same Kerberos configuration.

3. Start the Kafka broker, with JVM parameters to specify the Kerberos login configuration:

```
su - kafka
export KAFKA_OPTS="-Djava.security.krb5.conf=/etc/krb5.conf -
Djava.security.auth.login.config=/opt/kafka/config/jaas.conf"; /opt/kafka/bin/kafka-server-
start.sh -daemon /opt/kafka/config/server.properties
```

   If the broker and ZooKeeper cluster were previously configured and working with a non-Kerberos-based authentication system, it is possible to start the ZooKeeper and broker cluster and check for configuration errors in the logs.

   After starting the broker and Zookeeper instances, the cluster is now configured for Kerberos authentication.

Configure Kafka producer and consumer clients to use Kerberos authentication

Configure Kafka producer and consumer clients to use the Kerberos Key Distribution Center (KDC) for authentication using the user principals and keytabs previously created for **producer1** and **consumer1**.

1. Add the Kerberos configuration to the producer or consumer configuration file.
   For example:

   /opt/kafka/config/producer.properties

```
# ...
sasl.mechanism=GSSAPI (1)
security.protocol=SASL_PLAINTEXT (2)
sasl.kerberos.service.name=kafka (3)
sasl.jaas.config=com.sun.security.auth.module.Krb5LoginModule required \ (4)
    useKeyTab=true  \
    useTicketCache=false \
    storeKey=true  \
    keyTab="/opt/kafka/krb5/producer1.keytab" \
    principal="producer1/node1.example.redhat.com@EXAMPLE.REDHAT.COM";
# ...
```

   (1) Configuration for Kerberos (GSSAPI) authentication.

   (2) Kerberos uses the SASL plaintext (username/password) security protocol.

   (3) The service principal (user) for Kafka that was configured in the Kerberos KDC.

   (4) Configuration for the JAAS using the same properties defined in **jaas.conf**.

   /opt/kafka/config/consumer.properties

```
# ...
sasl.mechanism=GSSAPI
security.protocol=SASL_PLAINTEXT
sasl.kerberos.service.name=kafka
sasl.jaas.config=com.sun.security.auth.module.Krb5LoginModule required \
    useKeyTab=true  \
    useTicketCache=false \
    storeKey=true  \
    keyTab="/opt/kafka/krb5/consumer1.keytab" \
    principal="consumer1/node1.example.redhat.com@EXAMPLE.REDHAT.COM";
# ...
```

2. Run the clients to verify that you can send and receive messages from the Kafka brokers.
   Producer client:

```
export KAFKA_HEAP_OPTS="-Djava.security.krb5.conf=/etc/krb5.conf -
Dsun.security.krb5.debug=true"; /opt/kafka/bin/kafka-console-producer.sh --producer.config
/opt/kafka/config/producer.properties  --topic topic1 --bootstrap-server
node1.example.redhat.com:9094
```

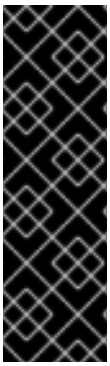
   Consumer client:

```
export KAFKA_HEAP_OPTS="-Djava.security.krb5.conf=/etc/krb5.conf -
Dsun.security.krb5.debug=true"; /opt/kafka/bin/kafka-console-consumer.sh --
consumer.config /opt/kafka/config/consumer.properties  --topic topic1 --bootstrap-server
node1.example.redhat.com:9094
```

Additional resources

- Kerberos man pages: krb5.conf(5), kinit(1), klist(1), and kdestroy(1)
- Example Kerberos server on RHEL set up configuration
- Example client application to authenticate with a Kafka cluster using Kerberos tickets

CHAPTER 15. CRUISE CONTROL FOR CLUSTER REBALANCING



IMPORTANT

Cruise Control for cluster rebalancing is a Technology Preview only. Technology Preview features are not supported with Red Hat production service-level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend implementing any Technology Preview features in production environments. This Technology Preview feature provides early access to upcoming product innovations, enabling you to test functionality and provide feedback during the development process. For more information about the support scope of Red Hat Technology Preview features, see Technology Preview Features Support Scope .

You can deploy Cruise Control to your AMQ Streams cluster and use it to rebalance the load across the Kafka brokers.

Cruise Control is an open source system for automating Kafka operations, such as monitoring cluster workload, rebalancing a cluster based on predefined constraints, and detecting and fixing anomalies. It consists of four components (Load Monitor, Analyzer, Anomaly Detector, and Executor) and a REST API.

When AMQ Streams and Cruise Control are both deployed to Red Hat Enterprise Linux, you can access Cruise Control features through the Cruise Control REST API. The following features are supported:

- Configuring *optimization goals* and *capacity limits*
- Using the /**rebalance** endpoint to:
  - Generate *optimization proposals*, as dry runs, based on the configured optimization goals or *user-provided goals* supplied as request parameters
  - Initiate an optimization proposal to rebalance the Kafka cluster
- Checking the progress of an active rebalance operation using the /**user_tasks** endpoint
- Stopping an active rebalance operation using the /**stop_proposal_execution** endpoint

All other Cruise Control features are not currently supported, including anomaly detection, notifications, write-your-own goals, and changing the topic replication factor. The web UI component (Cruise Control Frontend) is not supported.

Cruise Control for AMQ Streams on Red Hat Enterprise Linux is provided as a separate zipped distribution. For more information, see Section 15.2, “Downloading a Cruise Control archive” .

15.1. WHY USE CRUISE CONTROL?

Cruise Control reduces the time and effort involved in running an efficient Kafka cluster, with a more evenly balanced workload across the brokers.

A typical cluster can become unevenly loaded over time. Partitions that handle large amounts of message traffic might be unevenly distributed across the available brokers. To rebalance the cluster, administrators must monitor the load on brokers and manually reassign busy partitions to brokers with spare capacity.

Cruise Control automates this cluster rebalancing process. It constructs a *workload model* of resource utilization, based on CPU, disk, and network load. Using a set of configurable optimization goals, you can instruct Cruise Control to generate dry run optimization proposals for more balanced partition assignments.

After you have reviewed a dry run optimization proposal, you can instruct Cruise Control to initiate a cluster rebalance based on that proposal, or generate a new proposal.

When a cluster rebalancing operation is complete, the brokers are used more effectively and the load on the Kafka cluster is more evenly balanced.

Additional resources

- Cruise Control Wiki
- Section 15.5, "Optimization goals overview"
- Section 15.6, "Optimization proposals overview"
- Capacity configuration

15.2. DOWNLOADING A CRUISE CONTROL ARCHIVE

A zipped distribution of Cruise Control for AMQ Streams on Red Hat Enterprise Linux is available for download from the Red Hat Customer Portal .

Procedure

1. Download the latest version of the **Red Hat AMQ Streams Cruise Control**archive from the Red Hat Customer Portal .
2. Create the **/opt/cruise-control** directory:

```
sudo mkdir /opt/cruise-control
```

3. Extract the contents of the Cruise Control ZIP file to the new directory:

```
unzip amq-streams-y.y.y-cruise-control-bin.zip -d /opt/cruise-control
```

4. Change the ownership of the **/opt/cruise-control** directory to the **kafka** user:

```
sudo chown -R kafka:kafka /opt/cruise-control
```

15.3. DEPLOYING THE CRUISE CONTROL METRICS REPORTER

Before starting Cruise Control, you must configure the Kafka brokers to use the provided Cruise Control Metrics Reporter.

When loaded at runtime, the Metrics Reporter sends metrics to the **__CruiseControlMetrics** topic, one of three auto-created topics. Cruise Control uses these metrics to create and update the workload model and to calculate optimization proposals.

Prerequisites

- You are logged in to Red Hat Enterprise Linux as the **kafka** user.
- Kafka and ZooKeeper are running.
- Section 15.2, "Downloading a Cruise Control archive" .

Procedure

For each broker in the Kafka cluster and one at a time:

1. Stop the Kafka broker:

```
/opt/kafka/bin/kafka-server-stop.sh
```

2. Copy the Cruise Control Metrics Reporter **.jar** file to the Kafka libraries directory:

```
cp /opt/cruise-control/libs/cruise-control-metrics-reporter-y.y.yyy.redhat-0000x.jar
/opt/kafka/libs
```

3. In the Kafka configuration file (**/opt/kafka/config/server.properties**) configure the Cruise Control Metrics Reporter:

   a. Add the **CruiseControlMetricsReporter** class to the **metric.reporters** configuration option. Do not remove any existing Metrics Reporters.

```
metric.reporters=com.linkedin.kafka.cruisecontrol.metricsreporter.CruiseControlMetricsReporter
```

   b. Add the following configuration options and values to the Kafka configuration file:

```
cruise.control.metrics.topic.auto.create=true
cruise.control.metrics.topic.num.partitions=1
cruise.control.metrics.topic.replication.factor=1
```

   These options enable the Cruise Control Metrics Reporter to create the **__CruiseControlMetrics** topic with a log cleanup policy of **DELETE**. For more information, see Auto-created topics and Log cleanup policy for Cruise Control Metrics topic .

4. Configure SSL, if required.

   a. In the Kafka configuration file (**/opt/kafka/config/server.properties**) configure SSL between the Cruise Control Metrics Reporter and the Kafka broker by setting the relevant client configuration properties.
   The Metrics Reporter accepts all standard producer-specific configuration properties with the **cruise.control.metrics.reporter** prefix. For example: **cruise.control.metrics.reporter.ssl.truststore.password**.

   b. In the Cruise Control properties file (**/opt/cruise-control/config/cruisecontrol.properties**) configure SSL between the Kafka broker and the Cruise Control server by setting the relevant client configuration properties.
   Cruise Control inherits SSL client property options from Kafka and uses those properties for all Cruise Control server clients.

5. Restart the Kafka broker:

```
/opt/kafka/bin/kafka-server-start.sh
```

6. Repeat steps 1-5 for the remaining brokers.

15.4. CONFIGURING AND STARTING CRUISE CONTROL

Configure the properties used by Cruise Control and then start the Cruise Control server using the **cruise-control-start.sh** script. The server is hosted on a single machine for the whole Kafka cluster.

Three topics are auto-created when Cruise Control starts. For more information, see Auto-created topics.

Prerequisites

- You are logged in to Red Hat Enterprise Linux as the **kafka** user.
- Section 15.2, "Downloading a Cruise Control archive"
- Section 15.3, "Deploying the Cruise Control Metrics Reporter"

Procedure

1. Edit the Cruise Control properties file (**/opt/cruise-control/config/cruisecontrol.properties**).
2. Configure the properties shown in the following example configuration:

```
# The Kafka cluster to control.
bootstrap.servers=localhost:9092 1

# The replication factor of Kafka metric sample store topic
sample.store.topic.replication.factor=2 2

# The configuration for the BrokerCapacityConfigFileResolver (supports JBOD, non-JBOD,
and heterogeneous CPU core capacities)
#capacity.config.file=config/capacity.json
#capacity.config.file=config/capacityCores.json
capacity.config.file=config/capacityJBOD.json 3

# The list of goals to optimize the Kafka cluster for with pre-computed proposals
default.goals={List of default optimization goals} 4

# The list of supported goals
goals={list of master optimization goals} 5

# The list of supported hard goals
hard.goals={List of hard goals} 6

# How often should the cached proposal be expired and recalculated if necessary
proposal.expiration.ms=60000 7

# The zookeeper connect of the Kafka cluster
zookeeper.connect=localhost:2181 8
```

1 Host and port numbers of the Kafka broker (always port 9092).

2 Replication factor of the Kafka metric sample store topic. If you are evaluating Cruise Control in a single-node Kafka and ZooKeeper cluster, set this property to 1. For production

3 The configuration file that sets the maximum capacity limits for broker resources. Use the file that applies to your Kafka deployment configuration. For more information, see Capacity configuration.

4 Comma-separated list of default optimization goals, using fully-qualified domain names (FQDNs). Fifteen of the master optimization goals (see 5) are already set as default optimization goals; you can add or remove goals if desired. For more information, see Section 15.5, "Optimization goals overview".

5 Comma-separated list of master optimization goals, using FQDNs. To completely exclude goals from being used to generate optimization proposals, remove them from the list. For more information, see Section 15.5, "Optimization goals overview".

6 Comma-separated list of hard goals, using FQDNs. Six of the master optimization goals are already set as hard goals; you can add or remove goals if desired. For more information, see Section 15.5, "Optimization goals overview".

7 The interval, in milliseconds, for refreshing the cached optimization proposal that is generated from the default optimization goals. For more information, see Section 15.6, "Optimization proposals overview".

8 Host and port numbers of the ZooKeeper connection (always port 2181).

3. Start the Cruise Control server. The server starts on port 9092 by default; optionally, specify a different port.

```
cd /opt/cruise-control/
./bin/cruise-control-start.sh config/cruisecontrol.properties PORT
```

4. To verify that Cruise Control is running, send a GET request to the **/state** endpoint of the Cruise Control server:

```
curl 'http://HOST:PORT/kafkacruisecontrol/state'
```

Auto-created topics

The following table shows the three topics that are automatically created when Cruise Control starts. These topics are required for Cruise Control to work properly and must not be deleted or changed.

Table 15.1. Auto-created topics

Auto-created topic	Created by	Function
__CruiseControlMetrics	Cruise Control Metrics Reporter	Stores the raw metrics from the Metrics Reporter in each Kafka broker.
__KafkaCruiseControlPartitionMetricSamples	Cruise Control	Stores the derived metrics for each partition. These are created by the Metric Sample Aggregator.

Auto-created topic	Created by	Function
__KafkaCruiseControlModelTrainingSamples	Cruise Control	Stores the metrics samples used to create the Cluster Workload Model

To ensure that log compaction is *disabled* in the auto-created topics, make sure that you configure the Cruise Control Metrics Reporter as described in Section 15.3, "Deploying the Cruise Control Metrics Reporter". Log compaction can remove records that are needed by Cruise Control and prevent it from working properly.

Additional resources

- Log cleanup policy for Cruise Control Metrics topic

15.5. OPTIMIZATION GOALS OVERVIEW

To rebalance a Kafka cluster, Cruise Control uses optimization goals to generate optimization proposals. Optimization goals are constraints on workload redistribution and resource utilization across a Kafka cluster.

AMQ Streams on Red Hat Enterprise Linux supports all the optimization goals developed in the Cruise Control project. The supported goals, in the default descending order of priority, are as follows:

1. Rack-awareness
2. Replica capacity
3. Capacity: Disk capacity, Network inbound capacity, Network outbound capacity
4. CPU capacity
5. Replica distribution
6. Potential network output
7. Resource distribution: Disk utilization distribution, Network inbound utilization distribution, Network outbound utilization distribution
8. Leader bytes-in rate distribution
9. Topic replica distribution
10. CPU usage distribution
11. Leader replica distribution
12. Preferred leader election
13. Kafka Assigner disk usage distribution
14. Intra-broker disk capacity
15. Intra-broker disk usage

For more information on each optimization goal, see Goals in the Cruise Control Wiki.

Goals configuration in the Cruise Control properties file

You configure optimization goals in the **cruisecontrol.properties** file in the **cruise-control/config/** directory. There are configurations for hard optimization goals that must be satisfied, as well as master and default optimization goals.

Optional, user-provided optimization goals are set at runtime as parameters in requests to the **/rebalance** endpoint.

Optimization goals are subject to any capacity limits on broker resources.

The following sections describe each goal configuration in more detail.

Master optimization goals

The master optimization goals are available to all users. Goals that are not listed in the master optimization goals are not available for use in Cruise Control operations.

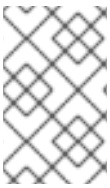
The following master optimization goals are preset in the **cruisecontrol.properties** file, in the **goals** property, in descending priority order:

```
RackAwareGoal; ReplicaCapacityGoal; DiskCapacityGoal; NetworkInboundCapacityGoal;
NetworkOutboundCapacityGoal; ReplicaDistributionGoal; PotentialNwOutGoal;
DiskUsageDistributionGoal; NetworkInboundUsageDistributionGoal;
NetworkOutboundUsageDistributionGoal; CpuUsageDistributionGoal; TopicReplicaDistributionGoal;
LeaderReplicaDistributionGoal; LeaderBytesInDistributionGoal; PreferredLeaderElectionGoal
```

For simplicity, we recommend that you do not change the preset master optimization goals, unless you need to completely exclude one or more goals from being used to generate optimization proposals. The priority order of the master optimization goals can be modified, if desired, in the configuration for default optimization goals.

If you need to modify the preset master optimization goals, specify a list of goals, in descending priority order, in the **goals** property. Use fully-qualified domain names as shown in the **cruisecontrol.properties** file.

You must specify at least one master goal, or Cruise Control will crash.



NOTE

If you change the preset master optimization goals, you must ensure that the configured **hard.goals** are a subset of the master optimization goals that you configured. Otherwise, errors will occur when generating optimization proposals.

Hard goals and soft goals

Hard goals are goals that *must* be satisfied in optimization proposals. Goals that are not configured as hard goals are known as *soft goals*. You can think of soft goals as *best effort* goals: they do not need to be satisfied in optimization proposals, but are included in optimization calculations.

Cruise Control will calculate optimization proposals that satisfy all the hard goals and as many soft goals as possible (in their priority order). An optimization proposal that does *not* satisfy all the hard goals is rejected by the Analyzer and is not sent to the user.

NOTE

For example, you might have a soft goal to distribute a topic's replicas evenly across the cluster (the topic replica distribution goal). Cruise Control will ignore this goal if doing so enables all the configured hard goals to be met.

The following master optimization goals are preset as hard goals in the **cruisecontrol.properties** file, in the **hard.goals** property:

```
RackAwareGoal; ReplicaCapacityGoal; DiskCapacityGoal; NetworkInboundCapacityGoal;
NetworkOutboundCapacityGoal; CpuCapacityGoal
```

To change the hard goals, edit the **hard.goals** property and specify the desired goals, using their fully-qualified domain names.

Increasing the number of hard goals reduces the likelihood that Cruise Control will calculate and generate valid optimization proposals.

Default optimization goals

Cruise Control uses the *default optimization goals* list to generate the *cached optimization proposal*. For more information, see Section 15.6, "Optimization proposals overview".

You can override the default optimization goals at runtime by setting user-provided optimization goals.

The following default optimization goals are preset in the **cruisecontrol.properties** file, in the **default.goals** property, in descending priority order:

```
RackAwareGoal; ReplicaCapacityGoal; DiskCapacityGoal; NetworkInboundCapacityGoal;
NetworkOutboundCapacityGoal; CpuCapacityGoal; ReplicaDistributionGoal; PotentialNwOutGoal;
DiskUsageDistributionGoal; NetworkInboundUsageDistributionGoal;
NetworkOutboundUsageDistributionGoal; CpuUsageDistributionGoal; TopicReplicaDistributionGoal;
LeaderReplicaDistributionGoal; LeaderBytesInDistributionGoal
```

You must specify at least one default goal, or Cruise Control will crash.

To modify the default optimization goals, specify a list of goals, in descending priority order, in the **default.goals** property. Default goals must be a subset of the master optimization goals; use fully-qualified domain names.

User-provided optimization goals

User-provided optimization goals narrow down the configured default goals for a particular optimization proposal. You can set them, as required, as parameters in HTTP requests to the **/rebalance** endpoint. For more information, see Section 15.9, "Generating optimization proposals".

User-provided optimization goals can generate optimization proposals for different scenarios. For example, you might want to optimize leader replica distribution across the Kafka cluster without considering disk capacity or disk utilization. So, you send a request to the **/rebalance** endpoint containing a single goal for leader replica distribution.

User-provided optimization goals must:

- Include all configured hard goals, or an error occurs
- Be a subset of the master optimization goals

To ignore the configured hard goals in an optimization proposal, add the **skip_hard_goals_check=true** parameter to the request.

Additional resources

- Section 15.8, "Cruise Control configuration"
- Configurations in the Cruise Control Wiki.

15.6. OPTIMIZATION PROPOSALS OVERVIEW

An *optimization proposal* is a summary of proposed changes that, if applied, will produce a more balanced Kafka cluster, with partition workloads distributed more evenly among the brokers. Each optimization proposal is based on the set of optimization goals that was used to generate it, subject to any configured capacity limits on broker resources.

When you make a POST request to the /**rebalance** endpoint, an optimization proposal is returned in response. Use the information in the proposal to decide whether to initiate a cluster rebalance based on the proposal. Alternatively, you can change the optimization goals and then generate another proposal.

By default, optimization proposals are generated as *dry runs* that must be initiated separately. There is no limit to the number of optimization proposals that can be generated.

Cached optimization proposal

Cruise Control maintains a *cached optimization proposal* based on the configured default optimization goals. Generated from the workload model, the cached optimization proposal is updated every 15 minutes to reflect the current state of the Kafka cluster.

The most recent cached optimization proposal is returned when the following goal configurations are used:

- The default optimization goals
- User-provided optimization goals that can be met by the current cached proposal

To change the cached optimization proposal refresh interval, edit the **proposal.expiration.ms** setting in the **cruisecontrol.properties** file. Consider a shorter interval for fast changing clusters, although this increases the load on the Cruise Control server.

Contents of optimization proposals

The following table describes the properties contained in an optimization proposal.

Table 15.2. Properties contained in an optimization proposal

Property	Description

Property	Description
n inter-broker replica (y MB) moves	**n**: The number of partition replicas that will be moved between separate brokers. **Performance impact during rebalance operation**: Relatively high. **y MB**: The sum of the size of each partition replica that will be moved to a separate broker. **Performance impact during rebalance operation**: Variable. The larger the number of MBs, the longer the cluster rebalance will take to complete.
n intra-broker replica (y MB) moves	**n**: The total number of partition replicas that will be transferred between the disks of the cluster's brokers. **Performance impact during rebalance operation**: Relatively high, but less than **inter-broker replica moves**. **y MB**: The sum of the size of each partition replica that will be moved between disks on the same broker. **Performance impact during rebalance operation**: Variable. The larger the number, the longer the cluster rebalance will take to complete. Moving a large amount of data between disks on the same broker has less impact than between separate brokers (see **inter-broker replica moves**).
n excluded topics	The number of topics excluded from the calculation of partition replica/leader movements in the optimization proposal. You can exclude topics in one of the following ways: In the **cruisecontrol.properties** file, specify a regular expression in the **topics.excluded.from.partition.movement** property. In a POST request to the /**rebalance** endpoint, specify a regular expression in the **excluded_topics** parameter. Topics that match the regular expression are listed in the response and will be excluded from the cluster rebalance.
n leadership moves	**n**: The number of partitions whose leaders will be switched to different replicas. This involves a change to ZooKeeper configuration. **Performance impact during rebalance operation**: Relatively low.
n recent windows	**n**: The number of metrics windows upon which the optimization proposal is based.

Property	Description
n% of the partitions covered	**n%**: The percentage of partitions in the Kafka cluster covered by the optimization proposal.
On-demand Balancedness Score Before (nn.yyy) After (nn.yyy)	Measurements of the overall balance of a Kafka Cluster. Cruise Control assigns a **Balancedness Score** to every optimization goal based on several factors, including priority (the goal's position in the list of **default.goals** or user-provided goals). The **On-demand Balancedness Score** is calculated by subtracting the sum of the **Balancedness Score** of each violated soft goal from 100. The **Before** score is based on the current configuration of the Kafka cluster. The **After** score is based on the generated optimization proposal.

Additional resources

- Section 15.5, "Optimization goals overview" .
- Section 15.9, "Generating optimization proposals"
- Section 15.10, "Initiating a cluster rebalance"

15.7. REBALANCE PERFORMANCE TUNING OVERVIEW

You can adjust several performance tuning options for cluster rebalances. These options control how partition replica and leadership movements in a rebalance are executed, as well as the bandwidth that is allocated to a rebalance operation.

Partition reassignment commands

Optimization proposals are composed of separate partition reassignment commands. When you initiate a proposal, the Cruise Control server applies these commands to the Kafka cluster.

A partition reassignment command consists of either of the following types of operations:

- **Partition movement** Involves transferring the partition replica and its data to a new location. Partition movements can take one of two forms:
  - Inter-broker movement: The partition replica is moved to a log directory on a different broker.
  - Intra-broker movement: The partition replica is moved to a different log directory on the same broker.
- **Leadership movement**: Involves switching the leader of the partition's replicas.

Cruise Control issues partition reassignment commands to the Kafka cluster in batches. The performance of the cluster during the rebalance is affected by the number of each type of movement contained in each batch.

To configure partition reassignment commands, see Rebalance tuning options.

Replica movement strategies

Cluster rebalance performance is also influenced by the *replica movement strategy* that is applied to the batches of partition reassignment commands. By default, Cruise Control uses the **BaseReplicaMovementStrategy**, which applies the commands in the order in which they were generated. However, if there are some very large partition reassignments early in the proposal, this strategy can slow down the application of the other reassignments.

Cruise Control provides three alternative replica movement strategies that can be applied to optimization proposals:

- **PrioritizeSmallReplicaMovementStrategy**: Order reassignments in ascending size.
- **PrioritizeLargeReplicaMovementStrategy**: Order reassignments in descending size.
- **PostponeUrpReplicaMovementStrategy**: Prioritize reassignments for replicas of partitions which have no out-of-sync replicas.

These strategies can be configured as a sequence. The first strategy attempts to compare two partition reassignments using its internal logic. If the reassignments are equivalent, then it passes them to the next strategy in the sequence to decide the order, and so on.

To configure replica movement strategies, see Rebalance tuning options.

Rebalance tuning options

Cruise Control provides several configuration options for tuning rebalance parameters. These options are set in the following ways:

- As properties, in the default Cruise Control configuration, in the **cruisecontrol.properties** file
- As parameters in POST requests to the **/rebalance** endpoint

The relevant configurations for both methods are summarized in the following table.

Table 15.3. Rebalance performance tuning configuration

Property and request parameter configurations	Description	Default Value
num.concurrent.partition.movements.per.broker	The maximum number of inter-broker partition movements in each partition reassignment batch	5
concurrent_partition_movements_per_broker		
num.concurrent.intra.broker.partition.movements	The maximum number of intra-broker partition movements in each partition reassignment batch	2
concurrent_intra_broker_partition_movements		
num.concurrent.leader.movements	The maximum number of partition leadership changes in each partition reassignment batch	1000

Property and request parameter configurations	Description	Default Value
concurrent_leader_movements		
default.replication.throttle **replication_throttle**	The bandwidth (in bytes per second) to assign to partition reassignment	Null (no limit)
default.replica.movement.strategies **replica_movement_strategies**	The list of strategies (in priority order) used to determine the order in which partition reassignment commands are executed for generated proposals. There are three strategies: **PrioritizeSmallReplicaMovementStrategy**, **PrioritizeLargeReplicaMovementStrategy**, and **PostponeUrpReplicaMovementStrategy**. For the property, use a comma-separated list of the fully qualified names of the strategy classes (add **com.linkedin.kafka.cruisecontrol.executor.strategy.** to the start of each class name). For the parameter, use a comma-separated list of the class names of the replica movement strategies.	**BaseReplicaMovementStrategy**

Changing the default settings affects the length of time that the rebalance takes to complete, as well as the load placed on the Kafka cluster during the rebalance. Using lower values reduces the load but increases the amount of time taken, and vice versa.

Additional resources

- Configurations in the Cruise Control Wiki.
- REST APIs in the Cruise Control Wiki.

15.8. CRUISE CONTROL CONFIGURATION

The **config/cruisecontrol.properties** file contains the configuration for Cruise Control. The file consists of properties in one of the following types:

- String
- Number
- Boolean

You can specify and configure all the properties listed in the Configurations section of the Cruise Control Wiki.

Capacity configuration

Cruise Control uses *capacity limits* to determine if certain resource-based optimization goals are being broken. An attempted optimization fails if one or more of these resource-based goals is set as a hard goal and then broken. This prevents the optimization from being used to generate an optimization proposal.

You specify capacity limits for Kafka broker resources in one of the following three **.json** files in **cruise-control/config**:

- **capacityJBOD.json**: For use in JBOD Kafka deployments (the default file).
- **capacity.json**: For use in non-JBOD Kafka deployments where each broker has the same number of CPU cores.
- **capacityCores.json**: For use in non-JBOD Kafka deployments where each broker has varying numbers of CPU cores.

Set the file in the **capacity.config.file** property in **cruisecontrol.properties**. The selected file will be used for broker capacity resolution. For example:

```
capacity.config.file=config/capacityJBOD.json
```

Capacity limits can be set for the following broker resources in the described units:

- **DISK**: Disk storage in MB
- **CPU**: CPU utilization as a percentage (0-100) or as a number of cores
- **NW_IN**: Inbound network throughput in KB per second
- **NW_OUT**: Outbound network throughput in KB per second

To apply the same capacity limits to every broker monitored by Cruise Control, set capacity limits for broker ID **-1**. To set different capacity limits for individual brokers, specify each broker ID and its capacity configuration.

Example capacity limits configuration

```
{
  "brokerCapacities":[
    {
      "brokerId": "-1",
      "capacity": {
        "DISK": "100000",
        "CPU": "100",
        "NW_IN": "10000",
        "NW_OUT": "10000"
```

```
    },
    "doc": "This is the default capacity. Capacity unit used for disk is in MB, cpu is in percentage,
network throughput is in KB."
  },
  {
    "brokerId": "0",
    "capacity": {
      "DISK": "500000",
      "CPU": "100",
      "NW_IN": "50000",
      "NW_OUT": "50000"
    },
    "doc": "This overrides the capacity for broker 0."
  }
 ]
}
```

For more information, see Populating the Capacity Configuration File in the Cruise Control Wiki.

Log cleanup policy for Cruise Control Metrics topic

It is important that the auto-created **__CruiseControlMetrics** topic (see auto-created topics) has a log cleanup policy of **DELETE** rather than **COMPACT**. Otherwise, records that are needed by Cruise Control might be removed.

As described in Section 15.3, "Deploying the Cruise Control Metrics Reporter", setting the following options in the Kafka configuration file ensures that the **COMPACT** log cleanup policy is correctly set:

- **cruise.control.metrics.topic.auto.create=true**
- **cruise.control.metrics.topic.num.partitions=1**
- **cruise.control.metrics.topic.replication.factor=1**

If topic auto-creation is *disabled* in the Cruise Control Metrics Reporter (**cruise.control.metrics.topic.auto.create=false**), but *enabled* in the Kafka cluster, then the **__CruiseControlMetrics** topic is still automatically created by the broker. In this case, you must change the log cleanup policy of the **__CruiseControlMetrics** topic to **DELETE** using the **kafka-configs.sh** tool.

1. Get the current configuration of the **__CruiseControlMetrics** topic:

```
bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --entity-type topics --entity-name
__CruiseControlMetrics --describe
```

2. Change the log cleanup policy in the topic configuration:

```
bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --entity-type topics --entity-name
__CruiseControlMetrics --alter --add-config cleanup.policy=delete
```

If topic auto-creation is *disabled* in both the Cruise Control Metrics Reporter *and* the Kafka cluster, you must create the **__CruiseControlMetrics** topic manually and then configure it to use the **DELETE** log cleanup policy using the **kafka-configs.sh** tool.

For more information, see Section 5.9, "Modifying a topic configuration".

Logging configuration

Cruise Control uses **log4j1** for all server logging. To change the default configuration, edit the **log4j.properties** file in **/opt/cruise-control/config/log4j.properties**.

You must restart the Cruise Control server before the changes take effect.

15.9. GENERATING OPTIMIZATION PROPOSALS

When you make a POST request to the **/rebalance** endpoint, Cruise Control generates an optimization proposal to rebalance the Kafka cluster, based on the provided optimization goals.

The optimization proposal is generated as a *dry run*, unless the **dryrun** parameter is supplied and set to **false**.

You can then analyze the information in the dry run optimization proposal and decide whether to initiate it.

Following are the key parameters that you can include in requests to the **/rebalance** endpoint. For information about all the available parameters, see REST APIs in the Cruise Control Wiki.

dryrun

type: boolean, default: true

Informs Cruise Control whether you want to generate an optimization proposal only (**true**), or generate an optimization proposal and perform a cluster rebalance (**false**).

excluded_topics

type: regex

A regular expression that matches the topics to exclude from the calculation of the optimization proposal.

goals

type: list of strings, default: the configured **default.goals** list

List of user-provided optimization goals to use to prepare the optimization proposal. If goals are not supplied, the configured **default.goals** list in the **cruisecontrol.properties** file is used.

skip_hard_goals_check

type: boolean, default: **false**

By default, Cruise Control checks that the user-provided optimization goals (in the **goals** parameter) contain all the configured hard goals (in **hard.goals**). A request fails if you supply goals that are not a subset of the configured **hard.goals**.

Set **skip_hard_goals_check** to **true** if you want to generate an optimization proposal with user-provided optimization goals that do not include all the configured **hard.goals**.

json

type: boolean, default: **false**

Controls the type of response returned by the Cruise Control server. If not supplied, or set to **false**, then Cruise Control returns text formatted for display on the command line. If you want to extract elements of the returned information programmatically, set **json=true**. This will return JSON formatted text that

can be piped to tools such as **jq**, or parsed in scripts and programs.

verbose

type: boolean, default: **false**

Controls the level of detail in responses that are returned by the Cruise Control server.

Prerequisites

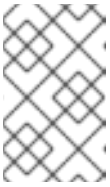
- Kafka and ZooKeeper are running
- Cruise Control is running

Procedure

1. To generate an optimization proposal formatted for the console, send a POST request to the **/rebalance** endpoint.
   - To use the configured **default.goals**:

     ```
     curl -v -X POST 'cruise-control-server:9090/kafkacruisecontrol/rebalance'
     ```

     The cached optimization proposal is immediately returned.

     NOTE

     If **NotEnoughValidWindows** is returned, Cruise Control has not yet recorded enough metrics data to generate an optimization proposal. Wait a few minutes and then resend the request.

   - To specify user-provided optimization goals instead of the configured **default.goals**, supply one or more goals in the **goals** parameter:

     ```
     curl -v -X POST 'cruise-control-server:9090/kafkacruisecontrol/rebalance?
     goals=RackAwareGoal,ReplicaCapacityGoal'
     ```

     If it satisfies the supplied goals, the cached optimization proposal is immediately returned. Otherwise, a new optimization proposal is generated using the supplied goals; this takes longer to calculate. You can enforce this behavior by adding the **ignore_proposal_cache=true** parameter to the request.

   - To specify user-provided optimization goals that do not include all the configured hard goals, add the **skip_hard_goal_check=true** parameter to the request:

     ```
     curl -v -X POST 'cruise-control-server:9090/kafkacruisecontrol/rebalance?
     goals=RackAwareGoal,ReplicaCapacityGoal,ReplicaDistributionGoal&skip_hard_goal_chec
     k=true'
     ```

2. Review the optimization proposal contained in the response. The properties describe the pending cluster rebalance operation.
   The proposal contains a high level summary of the proposed optimization, followed by summaries for each default optimization goal, and the expected cluster state after the proposal has executed.

Pay particular attention to the following information:

- The **Cluster load after rebalance** summary. If it meets your requirements, you should assess the impact of the proposed changes using the high level summary.
- **n inter-broker replica (y MB) moves** indicates how much data will be moved across the network between brokers. The higher the value, the greater the potential performance impact on the Kafka cluster during the rebalance.
- **n intra-broker replica (y MB) moves** indicates how much data will be moved within the brokers themselves (between disks). The higher the value, the greater the potential performance impact on individual brokers (although less than that of **n inter-broker replica (y MB) moves**).
- The number of leadership moves. This has a negligible impact on the performance of the cluster during the rebalance.

Asynchronous responses

The Cruise Control REST API endpoints timeout after 10 seconds by default, although proposal generation continues on the server. A timeout might occur if the most recent cached optimization proposal is not ready, or if user-provided optimization goals were specified with **ignore_proposal_cache=true**.

To allow you to retrieve the optimization proposal at a later time, take note of the request's unique identifier, which is given in the header of responses from the **/rebalance** endpoint.

To obtain the response using **curl**, specify the verbose (**-v**) option:

```
curl -v -X POST 'cruise-control-server:9090/kafkacruisecontrol/rebalance'
```

Here is an example header:

```
* Connected to cruise-control-server (::1) port 9090 (#0)
> POST /kafkacruisecontrol/rebalance HTTP/1.1
> Host: cc-host:9090
> User-Agent: curl/7.70.0
> Accept: /
>
* Mark bundle as not supporting multiuse
< HTTP/1.1 200 OK
< Date: Mon, 01 Jun 2020 15:19:26 GMT
< Set-Cookie: JSESSIONID=node01wk6vjzjj12go13m81o7no5p7h9.node0; Path=/
< Expires: Thu, 01 Jan 1970 00:00:00 GMT
< User-Task-ID: 274b8095-d739-4840-85b9-f4cfaaf5c201
< Content-Type: text/plain;charset=utf-8
< Cruise-Control-Version: 2.0.103.redhat-00002
< Cruise-Control-Commit_Id: 58975c9d5d0a78dd33cd67d4bcb497c9fd42ae7c
< Content-Length: 12368
< Server: Jetty(9.4.26.v20200117-redhat-00001)
```

If an optimization proposal is not ready within the timeout, you can re-submit the POST request, this time including the **User-Task-ID** of the original request in the header:

```
curl -v -X POST -H 'User-Task-ID: 274b8095-d739-4840-85b9-f4cfaaf5c201' 'cruise-control-server:9090/kafkacruisecontrol/rebalance'
```

What to do next

Section 15.10, “Initiating a cluster rebalance”

15.10. INITIATING A CLUSTER REBALANCE

If you are satisfied with an optimization proposal, you can instruct Cruise Control to initiate the cluster rebalance and begin reassigning partitions, as summarized in the proposal.

Leave as little time as possible between generating an optimization proposal and initiating the cluster rebalance. If some time has passed since you generated the original optimization proposal, the cluster state might have changed. Therefore, the cluster rebalance that is initiated might be different to the one you reviewed. If in doubt, first generate a new optimization proposal.

Only one cluster rebalance, with a status of "Active", can be in progress at a time.

Prerequisites

- You have generated an optimization proposal from Cruise Control.

Procedure

1. To execute the most recently generated optimization proposal, send a POST request to the **/rebalance** endpoint, with the **dryrun=false** parameter:

   ```
   curl -X POST 'cruise-control-server:9090/kafkacruisecontrol/rebalance?dryrun=false'
   ```

   Cruise Control initiates the cluster rebalance and returns the optimization proposal.

2. Check the changes that are summarized in the optimization proposal. If the changes are not what you expect, you can stop the rebalance.

3. Check the progress of the cluster rebalance using the **/user_tasks** endpoint. The cluster rebalance in progress has a status of "Active".
   To view all cluster rebalance tasks executed on the Cruise Control server:

   ```
   curl 'cruise-control-server:9090/kafkacruisecontrol/user_tasks'

   USER TASK ID      CLIENT ADDRESS  START TIME     STATUS  REQUEST URL
   c459316f-9eb5-482f-9d2d-97b5a4cd294d  0:0:0:0:0:0:0:1       2020-06-01_16:10:29 UTC
   Active      POST /kafkacruisecontrol/rebalance?dryrun=false
   445e2fc3-6531-4243-b0a6-36ef7c5059b4  0:0:0:0:0:0:0:1       2020-06-01_14:21:26 UTC
   Completed   GET /kafkacruisecontrol/state?json=true
   05c37737-16d1-4e33-8e2b-800dee9f1b01  0:0:0:0:0:0:0:1       2020-06-01_14:36:11 UTC
   Completed   GET /kafkacruisecontrol/state?json=true
   aebae987-985d-4871-8cfb-6134ecd504ab  0:0:0:0:0:0:0:1       2020-06-01_16:10:04 UTC
   ```

4. To view the status of a particular cluster rebalance task, supply the **user-task-ids** parameter and the task ID:

   ```
   curl 'cruise-control-server:9090/kafkacruisecontrol/user_tasks?user_task_ids=c459316f-
   9eb5-482f-9d2d-97b5a4cd294d'
   ```

15.11. STOPPING AN ACTIVE CLUSTER REBALANCE

You can stop the cluster rebalance that is currently in progress.

This instructs Cruise Control to finish the current batch of partition reassignments and then stop the rebalance. When the rebalance has stopped, completed partition reassignments have already been applied; therefore, the state of the Kafka cluster is different when compared to before the start of the rebalance operation. If further rebalancing is required, you should generate a new optimization proposal.

NOTE

The performance of the Kafka cluster in the intermediate (stopped) state might be worse than in the initial state.

Prerequisites

- A cluster rebalance is in progress (indicated by a status of "Active").

Procedure

- Send a POST request to the **/stop_proposal_execution** endpoint:

```
curl -X POST 'cruise-control-server:9090/kafkacruisecontrol/stop_proposal_execution'
```

Additional resources

- Section 15.9, “Generating optimization proposals”

CHAPTER 16. DISTRIBUTED TRACING

Distributed tracing allows you to track the progress of transactions between applications in a distributed system. In a microservices architecture, tracing tracks the progress of transactions between services. Trace data is useful for monitoring application performance and investigating issues with target systems and end-user applications.

In AMQ Streams on Red Hat Enterprise Linux, tracing facilitates the end-to-end tracking of messages: from source systems to Kafka, and then from Kafka to target systems and applications. Tracing complements the available JMX metrics.

How AMQ Streams supports tracing

Support for tracing is provided for the following clients and components.

Kafka clients:

- Kafka producers and consumers
- Kafka Streams API applications

Kafka components:

- Kafka Connect
- Kafka Bridge
- MirrorMaker
- MirrorMaker 2.0

To enable tracing, you perform four high-level tasks:

1. Enable a Jaeger tracer.
2. Enable the Interceptors:
   - For Kafka clients, you *instrument* your application code using the OpenTracing Apache Kafka Client Instrumentation library (included with AMQ Streams).
   - For Kafka components, you set configuration properties for each component.
3. Set tracing environment variables.
4. Deploy the client or component.

When instrumented, clients generate trace data. For example, when producing messages or writing offsets to the log.

Traces are sampled according to a sampling strategy and then visualized in the Jaeger user interface.

NOTE

Tracing is not supported for Kafka brokers.

Setting up tracing for applications and systems beyond AMQ Streams is outside the scope of this chapter. To learn more about this subject, search for "inject and extract" in the OpenTracing documentation.

Outline of procedures

To set up tracing for AMQ Streams, follow these procedures in order:

1. Set up tracing for clients:
    a. Initialize a Jaeger tracer for Kafka clients
    b. Instrument producers and consumers for tracing
    c. Instrument Kafka Streams applications for tracing
2. Set up tracing for MirrorMaker, MirrorMaker 2.0, and Kafka Connect:
    a. Enable tracing for MirrorMaker
    b. Enable tracing for MirrorMaker 2.0
    c. Enable tracing for Kafka Connect
3. Enable tracing for the Kafka Bridge

Prerequisites

- The Jaeger backend components are deployed to the host operating system. For deployment instructions, see the Jaeger deployment documentation.

16.1. OVERVIEW OF OPENTRACING AND JAEGER

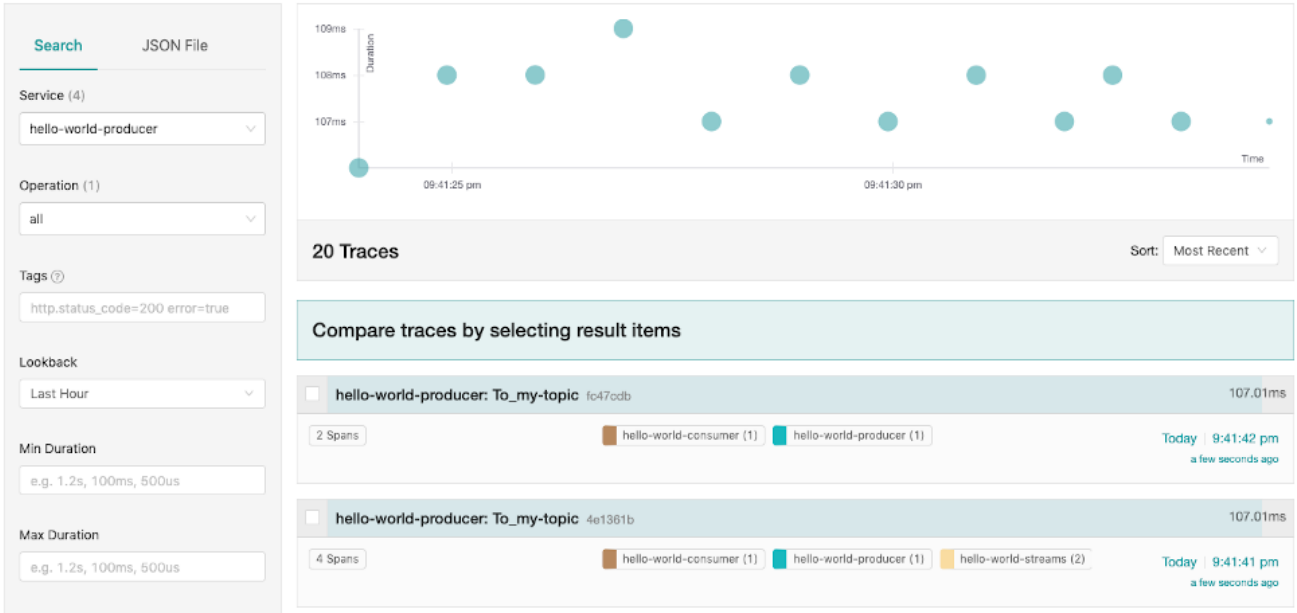
AMQ Streams uses the OpenTracing and Jaeger projects.

OpenTracing is an API specification that is independent from the tracing or monitoring system.

- The OpenTracing APIs are used to *instrument* application code
- Instrumented applications generate *traces* for individual transactions across the distributed system
- Traces are composed of *spans* that define specific units of work over time

Jaeger is a tracing system for microservices-based distributed systems.

- Jaeger implements the OpenTracing APIs and provides client libraries for instrumentation
- The Jaeger user interface allows you to query, filter, and analyze trace data



Additional resources

- OpenTracing
- Jaeger

16.2. SETTING UP TRACING FOR KAFKA CLIENTS

Initialize a Jaeger tracer to instrument your client applications for distributed tracing.

16.2.1. Initializing a Jaeger tracer for Kafka clients

Configure and initialize a Jaeger tracer using a set of tracing environment variables.

Procedure

In each client application:

1. Add Maven dependencies for Jaeger to the **pom.xml** file for the client application:

```
<dependency>
    <groupId>io.jaegertracing</groupId>
    <artifactId>jaeger-client</artifactId>
    <version>1.1.0.redhat-00002</version>
</dependency>
```

2. Define the configuration of the Jaeger tracer using the tracing environment variables.

3. Create the Jaeger tracer from the environment variables that you defined in step two:

```
Tracer tracer = Configuration.fromEnv().getTracer();
```

NOTE

For alternative ways to initialize a Jaeger tracer, see the Java OpenTracing library documentation.

4. Register the Jaeger tracer as a global tracer:

```
GlobalTracer.register(tracer);
```

A Jaeger tracer is now initialized for the client application to use.

16.2.2. Instrumenting producers and consumers for tracing

Use a Decorator pattern or Interceptors to instrument your Java producer and consumer application code for tracing.

Procedure

In the application code of each producer and consumer application:

1. Add a Maven dependency for OpenTracing to the producer or consumer's **pom.xml** file.

```
<dependency>
    <groupId>io.opentracing.contrib</groupId>
    <artifactId>opentracing-kafka-client</artifactId>
    <version>0.1.12.redhat-00001</version>
</dependency>
```

2. Instrument your client application code using either a Decorator pattern or Interceptors.

   - To use a Decorator pattern:

```
// Create an instance of the KafkaProducer:
KafkaProducer<Integer, String> producer = new KafkaProducer<>(senderProps);

// Create an instance of the TracingKafkaProducer:
TracingKafkaProducer<Integer, String> tracingProducer = new TracingKafkaProducer<>
(producer,
        tracer);

// Send:
tracingProducer.send(...);

// Create an instance of the KafkaConsumer:
KafkaConsumer<Integer, String> consumer = new KafkaConsumer<>(consumerProps);

// Create an instance of the TracingKafkaConsumer:
TracingKafkaConsumer<Integer, String> tracingConsumer = new
TracingKafkaConsumer<>(consumer,
        tracer);

// Subscribe:
tracingConsumer.subscribe(Collections.singletonList("messages"));

// Get messages:
ConsumerRecords<Integer, String> records = tracingConsumer.poll(1000);

// Retrieve SpanContext from polled record (consumer side):
```

```
ConsumerRecord<Integer, String> record = ...
SpanContext spanContext = TracingKafkaUtils.extractSpanContext(record.headers(),
tracer);
```

- To use Interceptors:

```
// Register the tracer with GlobalTracer:
GlobalTracer.register(tracer);

// Add the TracingProducerInterceptor to the sender properties:
senderProps.put(ProducerConfig.INTERCEPTOR_CLASSES_CONFIG,
        TracingProducerInterceptor.class.getName());

// Create an instance of the KafkaProducer:
KafkaProducer<Integer, String> producer = new KafkaProducer<>(senderProps);

// Send:
producer.send(...);

// Add the TracingConsumerInterceptor to the consumer properties:
consumerProps.put(ConsumerConfig.INTERCEPTOR_CLASSES_CONFIG,
        TracingConsumerInterceptor.class.getName());

// Create an instance of the KafkaConsumer:
KafkaConsumer<Integer, String> consumer = new KafkaConsumer<>(consumerProps);

// Subscribe:
consumer.subscribe(Collections.singletonList("messages"));

// Get messages:
ConsumerRecords<Integer, String> records = consumer.poll(1000);

// Retrieve the SpanContext from a polled message (consumer side):
ConsumerRecord<Integer, String> record = ...
SpanContext spanContext = TracingKafkaUtils.extractSpanContext(record.headers(),
tracer);
```

Custom span names in a Decorator pattern

A *span* is a logical unit of work in Jaeger, with an operation name, start time, and duration.

To use a Decorator pattern to instrument your producer and consumer applications, define custom span names by passing a **BiFunction** object as an additional argument when creating the **TracingKafkaProducer** and **TracingKafkaConsumer** objects. The OpenTracing Apache Kafka Client Instrumentation library includes several built-in span names.

Example: Using custom span names to instrument client application code in a Decorator pattern

```
// Create a BiFunction for the KafkaProducer that operates on (String operationName,
ProducerRecord consumerRecord) and returns a String to be used as the name:

BiFunction<String, ProducerRecord, String> producerSpanNameProvider =
    (operationName, producerRecord) -> "CUSTOM_PRODUCER_NAME";

// Create an instance of the KafkaProducer:
```

```
KafkaProducer<Integer, String> producer = new KafkaProducer<>(senderProps);

// Create an instance of the TracingKafkaProducer
TracingKafkaProducer<Integer, String> tracingProducer = new TracingKafkaProducer<>(producer,
        tracer,
        producerSpanNameProvider);

// Spans created by the tracingProducer will now have "CUSTOM_PRODUCER_NAME" as the span
name.

// Create a BiFunction for the KafkaConsumer that operates on (String operationName,
ConsumerRecord consumerRecord) and returns a String to be used as the name:

BiFunction<String, ConsumerRecord, String> consumerSpanNameProvider =
    (operationName, consumerRecord) -> operationName.toUpperCase();

// Create an instance of the KafkaConsumer:
KafkaConsumer<Integer, String> consumer = new KafkaConsumer<>(consumerProps);

// Create an instance of the TracingKafkaConsumer, passing in the consumerSpanNameProvider
BiFunction:

TracingKafkaConsumer<Integer, String> tracingConsumer = new TracingKafkaConsumer<>
(consumer,
        tracer,
        consumerSpanNameProvider);

// Spans created by the tracingConsumer will have the operation name as the span name, in upper-
case.
// "receive" -> "RECEIVE"
```

Built-in span names

When defining custom span names, you can use the following **BiFunctions** in the **ClientSpanNameProvider** class. If no **spanNameProvider** is specified, **CONSUMER_OPERATION_NAME** and **PRODUCER_OPERATION_NAME** are used.

Table 16.1. BiFunctions to define custom span names

BiFunction	Description
CONSUMER_OPERATION_NAME, PRODUCER_OPERATION_NAME	Returns the **operationName** as the span name: "receive" for consumers and "send" for producers.
CONSUMER_PREFIXED_OPERATION_NAME (String prefix), PRODUCER_PREFIXED_OPERATION_NAME(String prefix)	Returns a String concatenation of **prefix** and **operationName**.
CONSUMER_TOPIC, PRODUCER_TOPIC	Returns the name of the topic that the message was sent to or retrieved from in the format **(record.topic())**.

BiFunction	Description
PREFIXED_CONSUMER_TOPIC(String prefix), PREFIXED_PRODUCER_TOPIC(String prefix)	Returns a String concatenation of **prefix** and the topic name in the format **(record.topic())**.
CONSUMER_OPERATION_NAME_TOPIC, PRODUCER_OPERATION_NAME_TOPIC	Returns the operation name and the topic name: **"operationName - record.topic()"**.
CONSUMER_PREFIXED_OPERATION_NAME_TOPIC(String prefix), PRODUCER_PREFIXED_OPERATION_NAME_TOPIC(String prefix)	Returns a String concatenation of **prefix** and **"operationName - record.topic()"**.

16.2.3. Instrumenting Kafka Streams applications for tracing

Instrument Kafka Streams applications for distributed tracing using a supplier interface. This enables the Interceptors in the application.

Procedure

In each Kafka Streams application:

1. Add the **opentracing-kafka-streams** dependency to the Kafka Streams application's **pom.xml** file.

```
<dependency>
    <groupId>io.opentracing.contrib</groupId>
    <artifactId>opentracing-kafka-streams</artifactId>
    <version>0.1.12.redhat-00001</version>
</dependency>
```

2. Create an instance of the **TracingKafkaClientSupplier** supplier interface:

```
KafkaClientSupplier supplier = new TracingKafkaClientSupplier(tracer);
```

3. Provide the supplier interface to **KafkaStreams**:

```
KafkaStreams streams = new KafkaStreams(builder.build(), new StreamsConfig(config),
supplier);
streams.start();
```

16.3. SETTING UP TRACING FOR MIRRORMAKER AND KAFKA CONNECT

This section describes how to configure MirrorMaker, MirrorMaker 2.0, and Kafka Connect for distributed tracing.

You must enable a Jaeger tracer for each component.

16.3.1. Enabling tracing for MirrorMaker

Enable distributed tracing for MirrorMaker by passing the Interceptor properties as consumer and producer configuration parameters.

Messages are traced from the source cluster to the target cluster. The trace data records messages entering and leaving the MirrorMaker component.

Procedure

1. Configure and enable a Jaeger tracer.
2. Edit the **/opt/kafka/config/consumer.properties** file.
   Add the following Interceptor property:

```
consumer.interceptor.classes=io.opentracing.contrib.kafka.TracingConsumerInterceptor
```

3. Edit the **/opt/kafka/config/producer.properties** file.
   Add the following Interceptor property:

```
producer.interceptor.classes=io.opentracing.contrib.kafka.TracingProducerInterceptor
```

4. Start MirrorMaker with the consumer and producer configuration files as parameters:

```
su - kafka
/opt/kafka/bin/kafka-mirror-maker.sh --consumer.config /opt/kafka/config/consumer.properties
--producer.config /opt/kafka/config/producer.properties --num.streams=2
```

16.3.2. Enabling tracing for MirrorMaker 2.0

Enable distributed tracing for MirrorMaker 2.0 by defining the Interceptor properties in the MirrorMaker 2.0 properties file.

Messages are traced between Kafka clusters. The trace data records messages entering and leaving the MirrorMaker 2.0 component.

Procedure

1. Configure and enable a Jaeger tracer.
2. Edit the MirrorMaker 2.0 configuration properties file, **./config/connect-mirror-maker.properties**, and add the following properties:

```
header.converter=org.apache.kafka.connect.converters.ByteArrayConverter 1
consumer.interceptor.classes=io.opentracing.contrib.kafka.TracingConsumerInterceptor 2
producer.interceptor.classes=io.opentracing.contrib.kafka.TracingProducerInterceptor
```

1. Prevents Kafka Connect from converting message headers (containing trace IDs) to base64 encoding. This ensures that messages are the same in both the source and the target clusters.
2. Enables the Interceptors for MirrorMaker 2.0.

3. Start MirrorMaker 2.0 using the instructions in Section 10.4, "Synchronizing data between Kafka clusters using MirrorMaker 2.0".

Additional resources

- Chapter 10, *Using AMQ Streams with MirrorMaker 2.0*

16.3.3. Enabling tracing for Kafka Connect

Enable distributed tracing for Kafka Connect using configuration properties.

Only messages produced and consumed by Kafka Connect itself are traced. To trace messages sent between Kafka Connect and external systems, you must configure tracing in the connectors for those systems.

Procedure

1. Configure and enable a Jaeger tracer.
2. Edit the relevant Kafka Connect configuration file.
   - If you are running Kafka Connect in standalone mode, edit the **/opt/kafka/config/connect-standalone.properties** file.
   - If you are running Kafka Connect in distributed mode, edit the **/opt/kafka/config/connect-distributed.properties** file.
3. Add the following properties to the configuration file:

```
producer.interceptor.classes=io.opentracing.contrib.kafka.TracingProducerInterceptor
consumer.interceptor.classes=io.opentracing.contrib.kafka.TracingConsumerInterceptor
```

4. Save the configuration file.
5. Set tracing environment variables and then run Kafka Connect in standalone or distributed mode.

The Interceptors in Kafka Connect's internal consumers and producers are now enabled.

Additional resources

- Section 16.5, "Environment variables for tracing"
- Section 9.1.3, "Running Kafka Connect in standalone mode"
- Section 9.2.3, "Running distributed Kafka Connect"

16.4. ENABLING TRACING FOR THE KAFKA BRIDGE

Enable distributed tracing for the Kafka Bridge by editing the Kafka Bridge configuration file. You can then deploy a Kafka Bridge instance that is configured for distributed tracing to the host operating system.

Traces are generated when:

- The Kafka Bridge sends messages to HTTP clients and consumes messages from HTTP clients
- HTTP clients send HTTP requests to send and receive messages through the Kafka Bridge

To have end-to-end tracing, you must configure tracing in your HTTP clients.

Procedure

1. Edit the **config/application.properties** file in the Kafka Bridge installation directory. Remove the code comments from the following line:

```
bridge.tracing=jaeger
```

2. Save the configuration file.
3. Run the **bin/kafka_bridge_run.sh** script using the configuration properties as a parameter:

```
cd kafka-bridge-0.xy.x.redhat-0000x
./bin/kafka_bridge_run.sh --config-file=config/application.properties
```

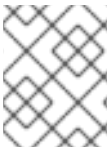
The Interceptors in the Kafka Bridge's internal consumers and producers are now enabled.

Additional resources

- Section 13.1.6, "Configuring Kafka Bridge properties"

16.5. ENVIRONMENT VARIABLES FOR TRACING

Use these environment variables when configuring a Jaeger tracer for Kafka clients and components.



NOTE

The tracing environment variables are part of the Jaeger project and are subject to change. For the latest environment variables, see the Jaeger documentation.

Table 16.2. Jaeger tracer environment variables

Property	Required	Description
JAEGER_SERVICE_NAME	Yes	The name of the Jaeger tracer service.
JAEGER_AGENT_HOST	No	The hostname for communicating with the **jaeger-agent** through the User Datagram Protocol (UDP).
JAEGER_AGENT_PORT	No	The port used for communicating with the **jaeger-agent** through UDP.

Property	Required	Description
JAEGER_ENDPOINT	No	The **traces** endpoint. Only define this variable if the client application will bypass the **jaeger-agent** and connect directly to the **jaeger-collector**.
JAEGER_AUTH_TOKEN	No	The authentication token to send to the endpoint as a bearer token.
JAEGER_USER	No	The username to send to the endpoint if using basic authentication.
JAEGER_PASSWORD	No	The password to send to the endpoint if using basic authentication.
JAEGER_PROPAGATION	No	A comma-separated list of formats to use for propagating the trace context. Defaults to the standard Jaeger format. Valid values are **jaeger** and **b3**.
JAEGER_REPORTER_LOG_SPANS	No	Indicates whether the reporter should also log the spans.
JAEGER_REPORTER_MAX_QUEUE_SIZE	No	The reporter's maximum queue size.
JAEGER_REPORTER_FLUSH_INTERVAL	No	The reporter's flush interval, in ms. Defines how frequently the Jaeger reporter flushes span batches.
JAEGER_SAMPLER_TYPE	No	The sampling strategy to use for client traces: • Constant • Probabilistic • Rate Limiting • Remote (the default) To sample all traces, use the Constant sampling strategy with a parameter of 1. For more information, see the Jaeger documentation.

Property	Required	Description
JAEGER_SAMPLER_PARAM	No	The sampler parameter (number).
JAEGER_SAMPLER_MANAGER_HOST_PORT	No	The hostname and port to use if a Remote sampling strategy is selected.
JAEGER_TAGS	No	A comma-separated list of tracer-level tags that are added to all reported spans. The value can also refer to an environment variable using the format **${envVarName:default}**. **:default** is optional and identifies a value to use if the environment variable cannot be found.

CHAPTER 17. KAFKA EXPORTER

Kafka Exporter is an open source project to enhance monitoring of Apache Kafka brokers and clients.

Kafka Exporter is provided with AMQ Streams for deployment with a Kafka cluster to extract additional metrics data from Kafka brokers related to offsets, consumer groups, consumer lag, and topics.

The metrics data is used, for example, to help identify slow consumers.

Lag data is exposed as Prometheus metrics, which can then be presented in Grafana for analysis.

If you are already using Prometheus and Grafana for monitoring of built-in Kafka metrics, you can configure Prometheus to also scrape the Kafka Exporter Prometheus endpoint.

Additional resources

Kafka exposes metrics through JMX, which can then be exported as Prometheus metrics.

- Chapter 8, *Monitoring your cluster using JMX*

17.1. CONSUMER LAG

Consumer lag indicates the difference in the rate of production and consumption of messages. Specifically, consumer lag for a given consumer group indicates the delay between the last message in the partition and the message being currently picked up by that consumer. The lag reflects the position of the consumer offset in relation to the end of the partition log.

This difference is sometimes referred to as the *delta* between the producer offset and consumer offset, the read and write positions in the Kafka broker topic partitions.

Suppose a topic streams 100 messages a second. A lag of 1000 messages between the producer offset (the topic partition head) and the last offset the consumer has read means a 10-second delay.

The importance of monitoring consumer lag

For applications that rely on the processing of (near) real-time data, it is critical to monitor consumer lag to check that it does not become too big. The greater the lag becomes, the further the process moves from the real-time processing objective.

Consumer lag, for example, might be a result of consuming too much old data that has not been purged, or through unplanned shutdowns.

Reducing consumer lag

Typical actions to reduce lag include:

- Scaling-up consumer groups by adding new consumers
- Increasing the retention time for a message to remain in a topic
- Adding more disk capacity to increase the message buffer

Actions to reduce consumer lag depend on the underlying infrastructure and the use cases AMQ Streams is supporting. For instance, a lagging consumer is less likely to benefit from the broker being able to service a fetch request from its disk cache. And in certain cases, it might be acceptable to automatically drop messages until a consumer has caught up.

17.2. KAFKA EXPORTER ALERTING RULE EXAMPLES

The sample alert notification rules specific to Kafka Exporter are as follows:

UnderReplicatedPartition

An alert to warn that a topic is under-replicated and the broker is not replicating enough partitions. The default configuration is for an alert if there are one or more under-replicated partitions for a topic. The alert might signify that a Kafka instance is down or the Kafka cluster is overloaded. A planned restart of the Kafka broker may be required to restart the replication process.

TooLargeConsumerGroupLag

An alert to warn that the lag on a consumer group is too large for a specific topic partition. The default configuration is 1000 records. A large lag might indicate that consumers are too slow and are falling behind the producers.

NoMessageForTooLong

An alert to warn that a topic has not received messages for a period of time. The default configuration for the time period is 10 minutes. The delay might be a result of a configuration issue preventing a producer from publishing messages to the topic.

You can adapt alerting rules according to your specific needs.

Additional resources

For more information about setting up alerting rules, see Configuration in the Prometheus documentation.

17.3. KAFKA EXPORTER METRICS

Lag information is exposed by Kafka Exporter as Prometheus metrics for presentation in Grafana.

Kafka Exporter exposes metrics data for brokers, topics, and consumer groups.

Table 17.1. Broker metrics output

Name	Information
kafka_brokers	Number of brokers in the Kafka cluster

Table 17.2. Topic metrics output

Name	Information
kafka_topic_partitions	Number of partitions for a topic
kafka_topic_partition_current_offset	Current topic partition offset for a broker
kafka_topic_partition_oldest_offset	Oldest topic partition offset for a broker
kafka_topic_partition_in_sync_replica	Number of in-sync replicas for a topic partition
kafka_topic_partition_leader	Leader broker ID of a topic partition

Name	Information
kafka_topic_partition_leader_is_preferred	Shows **1** if a topic partition is using the preferred broker
kafka_topic_partition_replicas	Number of replicas for this topic partition
kafka_topic_partition_under_replicated_partition	Shows **1** if a topic partition is under-replicated

Table 17.3. Consumer group metrics output

Name	Information
kafka_consumergroup_current_offset	Current topic partition offset for a consumer group
kafka_consumergroup_lag	Current approximate lag for a consumer group at a topic partition

17.4. RUNNING KAFKA EXPORTER

Kafka Exporter is provided with the download archive used for Installing AMQ Streams.

You can run it to expose Prometheus metrics for presentation in a Grafana dashboard.

Prerequisites

- AMQ Streams is installed on the host

This procedure assumes you already have access to a Grafana user interface and Prometheus is deployed and added as a data source.

Procedure

1. Run the Kafka Exporter script using appropriate configuration parameter values.

```
./bin/kafka_exporter --kafka.server=<kafka-bootstrap-address>:9092 --kafka.version=2.6.0 --<my-other-parameters>
```

The parameters require a double-hyphen convention, such as **--kafka.server**.

Table 17.4. Kafka Exporter configuration parameters

Option	Description	Default
kafka.server	Host/post address of the Kafka server.	**kafka:9092**
kafka.version	Kafka broker version.	**1.0.0**

Option	Description	Default
group.filter	A regular expression to specify the consumer groups to include in the metrics.	**.*** (all)
topic.filter	A regular expression to specify the topics to include in the metrics.	**.*** (all)
sasl.<*parameter*>	Parameters to enable and connect to the Kafka cluster using SASL/PLAIN authentication, with user name and password.	**false**
tls.<*parameter*>	Parameters to enable connect to the Kafka cluster using TLS authentication, with optional certificate and key.	**false**
web.listen-address	Port address to expose the metrics.	**:9308**
web.telemetry-path	Path for the exposed metrics.	**/metrics**
log.level	Logging configuration, to log messages with a given severity (debug, info, warn, error, fatal) or above.	**info**
log.enable-sarama	Boolean to enable Sarama logging, a Go client library used by the Kafka Exporter.	**false**

You can use **kafka_exporter --help** for information on the properties.

2. Configure Prometheus to monitor the Kafka Exporter metrics.
For more information on configuring Prometheus, see the Prometheus documentation.

3. Enable Grafana to present the Kafka Exporter metrics data exposed by Prometheus.
For more information, see Presenting Kafka Exporter metrics in Grafana .

17.5. PRESENTING KAFKA EXPORTER METRICS IN GRAFANA

Using Kafka Exporter Prometheus metrics as a data source, you can create a dashboard of Grafana charts.

For example, from the metrics you can create the following Grafana charts:

- Message in per second (from topics)

- Message in per minute (from topics)
- Lag by consumer group
- Messages consumed per minute (by consumer groups)

When metrics data has been collected for some time, the Kafka Exporter charts are populated.

Use the Grafana charts to analyze lag and to check if actions to reduce lag are having an impact on an affected consumer group. If, for example, Kafka brokers are adjusted to reduce lag, the dashboard will show the *Lag by consumer group* chart going down and the *Messages consumed per minute* chart going up.

Additional resources

- Example dashboard for Kafka Exporter
- Grafana documentation

CHAPTER 18. AMQ STREAMS AND KAFKA UPGRADES

AMQ Streams can be upgraded with no cluster downtime. Each version of AMQ Streams supports one or more versions of Apache Kafka: you can upgrade to a higher Kafka version as long as it is supported by your version of AMQ Streams. Newer versions of AMQ Streams may support newer versions of Kafka, but you need to upgrade AMQ Streams *before* you can upgrade to a higher supported Kafka version.

18.1. UPGRADE PREREQUISITES

Before you begin the upgrade process, make sure that:

- AMQ Streams is installed. For instructions, see Chapter 2, *Getting started*.
- You are familiar with any upgrade changes described in the AMQ Streams 1.6 on Red Hat Enterprise Linux Release Notes.

18.2. UPGRADE PROCESS

Upgrading AMQ Streams is a two-stage process. To upgrade brokers and clients without downtime, you *must* complete the upgrade procedures in the following order:

1. Upgrade to the latest AMQ Streams version.
   - Upgrading to AMQ Streams 1.6
2. Upgrade all Kafka brokers and client applications to the latest Kafka version
   - Upgrading Kafka

18.3. KAFKA VERSIONS

Kafka's log message format version and inter-broker protocol version specify the log format version appended to messages and the version of protocol used in a cluster. As a result, the upgrade process involves making configuration changes to existing Kafka brokers and code changes to client applications (consumers and producers) to ensure the correct versions are used.

The following table shows the differences between Kafka versions:

Kafka version	Interbroker protocol version	Log message format version	ZooKeeper version
2.5.0	2.5	2.5	3.5.8
2.6.0	2.6	2.6	3.5.8

Message format version

When a producer sends a message to a Kafka broker, the message is encoded using a specific format. The format can change between Kafka releases, so messages include a version identifying which version of the format they were encoded with. You can configure a Kafka broker to convert messages from newer format versions to a given older format version before the broker appends the message to the log.

In Kafka, there are two different methods for setting the message format version:

- The **message.format.version** property is set on topics.
- The **log.message.format.version** property is set on Kafka brokers.

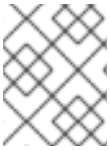
The default value of **message.format.version** for a topic is defined by the **log.message.format.version** that is set on the Kafka broker. You can manually set the **message.format.version** of a topic by modifying its topic configuration.

The upgrade tasks in this section assume that the message format version is defined by the **log.message.format.version**.

18.4. UPGRADING TO AMQ STREAMS 1.6

The steps to upgrade your deployment to use AMQ Streams 1.6 are outlined in this section.

The availability of Kafka clusters managed by AMQ Streams is not affected by the upgrade operation.



NOTE

Refer to the documentation supporting a specific version of AMQ Streams for information on how to upgrade to that version.

18.4.1. Upgrading Kafka brokers and ZooKeeper

This procedure describes how to upgrade Kafka brokers and ZooKeeper on a host machine to use the latest version of AMQ Streams.

Prerequisites

- You are logged in to Red Hat Enterprise Linux as the **kafka** user.

Procedure

For each Kafka broker in your AMQ Streams cluster and one at a time:

1. Download the AMQ Streams archive from the Customer Portal.

NOTE

If prompted, log in to your Red Hat account.

2. On the command line, create a temporary directory and extract the contents of the **amq-streams-x.y.z-bin.zip** file.

```
mkdir /tmp/kafka
unzip amq-streams-x.y.z-bin.zip -d /tmp/kafka
```

3. If running, stop ZooKeeper and the Kafka broker running on the host.

```
/opt/kafka/bin/zookeeper-server-stop.sh
/opt/kafka/bin/kafka-server-stop.sh
jcmd | grep zookeeper
```

```
jcmd | grep kafka
```

4. Delete the **libs**, **bin**, and **docs** directories from your existing installation:

```
rm -rf /opt/kafka/libs /opt/kafka/bin /opt/kafka/docs
```

5. Copy the **libs**, **bin**, and **docs** directories from the temporary directory:

```
cp -r /tmp/kafka/kafka_y.y-x.x.x/libs /opt/kafka/
cp -r /tmp/kafka/kafka_y.y-x.x.x/bin /opt/kafka/
cp -r /tmp/kafka/kafka_y.y-x.x.x/docs /opt/kafka/
```

6. Delete the temporary directory.

```
rm -r /tmp/kafka
```

7. In a text editor, open the broker properties file, commonly stored in the **/opt/kafka/config/** directory.

8. Check that the **inter.broker.protocol.version** and **log.message.format.version** properties are set to the *current* version:

```
inter.broker.protocol.version=2.5
log.message.format.version=2.5
```

   Leaving the **inter.broker.protocol.version** unchanged ensures that the brokers can continue to communicate with each other throughout the upgrade.

   If the properties are not configured, add them with the current version.

9. Restart the updated ZooKeeper and Kafka broker:

```
/opt/kafka/bin/zookeeper-server-start.sh -daemon /opt/kafka/config/zookeeper.properties
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

   The Kafka broker and Zookeeper will start using the binaries for the latest Kafka version.

10. Verify that the restarted Kafka broker has caught up with the partition replicas it is following. Use the **kafka-topics.sh** tool to ensure that all replicas contained in the broker are back in sync. For instructions, see Listing and describing topics.

11. Perform the procedures to upgrade Kafka, as described in Section 18.5, "Upgrading Kafka".

18.4.2. Upgrading Kafka Connect

This procedure describes how to upgrade a Kafka Connect cluster on a host machine.

Kafka Connect is a client application and should be included in your chosen strategy for upgrading clients. For more information, see Strategies for upgrading clients.

Prerequisites

- You are logged in to Red Hat Enterprise Linux as the **kafka** user.

- Kafka Connect is not started.

Procedure

For each Kafka broker in your AMQ Streams cluster and one at a time:

1. Download the AMQ Streams archive from the Customer Portal.

NOTE

If prompted, log in to your Red Hat account.

2. On the command line, create a temporary directory and extract the contents of the **amq-streams-x.y.z-bin.zip** file.

```
mkdir /tmp/kafka
unzip amq-streams-x.y.z-bin.zip -d /tmp/kafka
```

3. If running, stop the Kafka broker and ZooKeeper running on the host.

```
/opt/kafka/bin/kafka-server-stop.sh
/opt/kafka/bin/zookeeper-server-stop.sh
```

4. Delete the **libs**, **bin**, and **docs** directories from your existing installation:

```
rm -rf /opt/kafka/libs /opt/kafka/bin /opt/kafka/docs
```

5. Copy the **libs**, **bin**, and **docs** directories from the temporary directory:

```
cp -r /tmp/kafka/kafka_y.y-x.x.x/libs /opt/kafka/
cp -r /tmp/kafka/kafka_y.y-x.x.x/bin /opt/kafka/
cp -r /tmp/kafka/kafka_y.y-x.x.x/docs /opt/kafka/
```

6. Delete the temporary directory.

```
rm -r /tmp/kafka
```

7. Start Kafka Connect in either standalone or distributed mode.

- To start in standalone mode, run the **connect-standalone.sh** script. Specify the Kafka Connect standalone configuration file and the configuration files of your Kafka Connect connectors.

```
su - kafka
/opt/kafka/bin/connect-standalone.sh /opt/kafka/config/connect-standalone.properties
connector1.properties
[connector2.properties ...]
```

- To start in distributed mode, start the Kafka Connect workers with the **/opt/kafka/config/connect-distributed.properties** configuration file on all Kafka Connect nodes:

```
su - kafka
/opt/kafka/bin/connect-distributed.sh /opt/kafka/config/connect-distributed.properties
```

8. Verify that Kafka Connect is running:
   - In standalone mode:

     ```
     jcmd | grep ConnectStandalone
     ```

   - In distributed mode:

     ```
     jcmd | grep ConnectDistributed
     ```

9. Verify that Kafka Connect is producing and consuming data as expected.

Additional resources

- Running Kafka Connect in standalone mode
- Running distributed Kafka Connect
- Strategies for upgrading clients

18.5. UPGRADING KAFKA

After you have upgraded your binaries to use the latest version of AMQ Streams , you can upgrade your brokers and clients to use a higher supported version of Kafka.

Take care to follow the steps in the correct order:

1. Section 18.5.1, “Upgrading Kafka brokers to use the new inter-broker protocol version”
2. Section 18.5.3, “Upgrading client applications to the new Kafka version”
3. Section 18.5.4, “Upgrading Kafka brokers to use the new message format version”

Following the Kafka upgrade, if required, you can upgrade Kafka consumers to use the incremental cooperative rebalance protocol:

1. Section 18.5.5, “Upgrading consumers and Kafka Streams applications to cooperative rebalancing”

18.5.1. Upgrading Kafka brokers to use the new inter-broker protocol version

Manually configure and restart all Kafka brokers to use the new inter-broker protocol version. After performing these steps, data is transmitted between the Kafka brokers using the new inter-broker protocol version.

Messages received are still appended to the message logs in the earlier message format version.

WARNING

Downgrading AMQ Streams is not possible after completing this procedure.

Prerequisites

- You have updated the ZooKeeper binaries and upgraded all Kafka brokers to AMQ Streams 1.6
- You are logged in to Red Hat Enterprise Linux as the **kafka** user.

Procedure

For each Kafka broker in your AMQ Streams cluster and one at a time:

1. In a text editor, open the broker properties file for the Kafka broker you want to update. Broker properties files are commonly stored in the **/opt/kafka/config/** directory.
2. Set the **inter.broker.protocol.version** to **2.6**.

```
inter.broker.protocol.version=2.6
```

3. On the command line, stop the Kafka broker that you modified:

```
/opt/kafka/bin/kafka-server-stop.sh
jcmd | grep kafka
```

4. Restart the Kafka broker that you modified:

```
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

5. Verify that the restarted Kafka broker has caught up with the partition replicas it is following. Use the **kafka-topics.sh** tool to ensure that all replicas contained in the broker are back in sync. For instructions, see Listing and describing topics.

18.5.2. Strategies for upgrading clients

The best approach to upgrading your client applications (including Kafka Connect connectors) depends on your particular circumstances.

Consuming applications need to receive messages in a message format that they understand. You can ensure that this is the case in one of two ways:

- By upgrading all the consumers for a topic *before* upgrading any of the producers.
- By having the brokers down-convert messages to an older format.

Using broker down-conversion puts extra load on the brokers, so it is not ideal to rely on down-conversion for all topics for a prolonged period of time. For brokers to perform optimally they should not be down converting messages at all.

Broker down-conversion is configured in two ways:

- The topic-level **message.format.version** configures it for a single topic.
- The broker-level **log.message.format.version** is the default for topics that do not have the topic-level **message.format.version** configured.

Messages published to a topic in a new-version format will be visible to consumers, because brokers perform down-conversion when they receive messages from producers, not when they are sent to consumers.

There are a number of strategies you can use to upgrade your clients:

Consumers first

1. Upgrade all the consuming applications.
2. Change the broker-level **log.message.format.version** to the new version.
3. Upgrade all the producing applications.
   This strategy is straightforward, and avoids any broker down-conversion. However, it assumes that all consumers in your organization can be upgraded in a coordinated way, and it does not work for applications that are both consumers and producers. There is also a risk that, if there is a problem with the upgraded clients, new-format messages might get added to the message log so that you cannot revert to the previous consumer version.

Per-topic consumers first

For each topic:

1. Upgrade all the consuming applications.
2. Change the topic-level **message.format.version** to the new version.
3. Upgrade all the producing applications.
   This strategy avoids any broker down-conversion, and means you can proceed on a topic-by-topic basis. It does not work for applications that are both consumers and producers of the same topic. Again, it has the risk that, if there is a problem with the upgraded clients, new-format messages might get added to the message log.

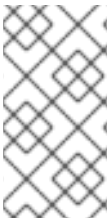
Per-topic consumers first, with down conversion

For each topic:

1. Change the topic-level **message.format.version** to the old version (or rely on the topic defaulting to the broker-level **log.message.format.version**).
2. Upgrade all the consuming and producing applications.
3. Verify that the upgraded applications function correctly.
4. Change the topic-level **message.format.version** to the new version.
   This strategy requires broker down-conversion, but the load on the brokers is minimized because it is only required for a single topic (or small group of topics) at a time. It also works for applications that are both consumers and producers of the same topic. This approach ensures that the upgraded producers and consumers are working correctly before you commit to using the new message format version.

   The main drawback of this approach is that it can be complicated to manage in a cluster with many topics and applications.

Other strategies for upgrading client applications are also possible.



NOTE

It is also possible to apply multiple strategies. For example, for the first few applications and topics the "per-topic consumers first, with down conversion" strategy can be used. When this has proved successful another, more efficient strategy can be considered acceptable to use instead.

18.5.3. Upgrading client applications to the new Kafka version

This procedure describes one possible approach to upgrading your client applications to the Kafka version used for AMQ Streams 1.6.

The procedure is based on the "per-topic consumers first, with down conversion" approach outlined in Strategies for upgrading clients.

Client applications include producers, consumers, Kafka Connect, Kafka Streams applications, and MirrorMaker.

Prerequisites

- You have updated the ZooKeeper binaries and upgraded all Kafka brokers to AMQ Streams 1.6
- You have configured Kafka brokers to use the new inter-broker protocol version.
- You are logged in to Red Hat Enterprise Linux as the **kafka** user.

Procedure

For each topic:

1. On the command line, set the **message.format.version** configuration option to **2.5**.

```
bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --entity-type topics --entity-name
<TopicName> --alter --add-config message.format.version=2.5
```

2. Upgrade all the consumers and producers for the topic.
3. Optionally, to upgrade consumers and Kafka Streams applications to use the *incremental cooperative rebalance* protocol, which was added in Kafka 2.4.0, see Section 18.5.5, "Upgrading consumers and Kafka Streams applications to cooperative rebalancing".
4. Verify that the upgraded applications function correctly.
5. Change the topic's **message.format.version** configuration option to **2.6**.

```
bin/kafka-configs.sh --bootstrap-server <BrokerAddress> --entity-type topics --entity-name
<TopicName> --alter --add-config message.format.version=2.6
```

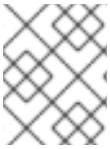
Additional resources

- Strategies for upgrading clients

18.5.4. Upgrading Kafka brokers to use the new message format version

When client applications have been upgraded, you can update the Kafka brokers to use the new message format version.

If you did *not* modify topic configurations when you upgraded your client applications to use the Kafka version required for AMQ Streams 1.6, the Kafka brokers are now converting messages down to the previous message format version, which can cause a reduction in performance. Therefore, it is important that you update all Kafka brokers to use the new message format version as soon as possible.



NOTE

Update and restart the Kafka brokers one-by-one. Before you restart a modified broker, stop the broker you configured and restarted previously.

Prerequisites

- You have updated the ZooKeeper binaries and upgraded all Kafka brokers to AMQ Streams 1.6
- You have configured Kafka brokers to use the new inter-broker protocol version.
- You have upgraded supported client applications that consume messages from topics for which the **message.format.version** property is *not* explicitly configured at the topic level.
- You are logged in to Red Hat Enterprise Linux as the **kafka** user.

Procedure

For each Kafka broker in your AMQ Streams cluster and one at a time:

1. In a text editor, open the broker properties file for the Kafka broker you want to update. Broker properties files are commonly stored in the **/opt/kafka/config/** directory.
2. Set the **log.message.format.version** to **2.6**.

```
log.message.format.version=2.6
```

3. On the command line, stop the Kafka broker that you most recently modified and restarted as part of this procedure. If you are modifying the first Kafka broker in this procedure, go to step four.

```
/opt/kafka/bin/kafka-server-stop.sh
jcmd | grep kafka
```

4. Restart the Kafka broker whose configuration you modified in step two:

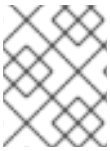
```
/opt/kafka/bin/kafka-server-start.sh -daemon /opt/kafka/config/server.properties
```

5. Verify that the restarted Kafka broker has caught up with the partition replicas it is following. Use the **kafka-topics.sh** tool to ensure that all replicas contained in the broker are back in sync. For instructions, see Listing and describing topics.

18.5.5. Upgrading consumers and Kafka Streams applications to cooperative rebalancing

You can upgrade Kafka consumers and Kafka Streams applications to use the *incremental cooperative rebalance* protocol for partition rebalances instead of the default *eager rebalance* protocol. The new protocol was added in Kafka 2.4.0.

Consumers keep their partition assignments in a cooperative rebalance and only revoke them at the end of the process, if needed to achieve a balanced cluster. This reduces the unavailability of the consumer group or Kafka Streams application.



NOTE

Upgrading to the incremental cooperative rebalance protocol is optional. The eager rebalance protocol is still supported.

Prerequisites

- Section 18.4, "Upgrading to AMQ Streams 1.6"
- Section 18.5.1, "Upgrading Kafka brokers to use the new inter-broker protocol version"
- Section 18.5.3, "Upgrading client applications to the new Kafka version"

Procedure

To upgrade a Kafka consumer to use the incremental cooperative rebalance protocol:

1. Replace the Kafka clients **.jar** file with the new version.
2. In the consumer configuration, append **cooperative-sticky** to the **partition.assignment.strategy**. For example, if the **range** strategy is set, change the configuration to **range, cooperative-sticky**.
3. Restart each consumer in the group in turn, waiting for the consumer to rejoin the group after each restart.
4. Reconfigure each consumer in the group by removing the earlier **partition.assignment.strategy** from the consumer configuration, leaving only the **cooperative-sticky** strategy.
5. Restart each consumer in the group in turn, waiting for the consumer to rejoin the group after each restart.

To upgrade a Kafka Streams application to use the incremental cooperative rebalance protocol:

1. Replace the Kafka Streams **.jar** file with the new version.
2. In the Kafka Streams configuration, set the **upgrade.from** configuration parameter to the Kafka version you are upgrading from (for example, 2.3).
3. Restart each of the stream processors (nodes) in turn.
4. Remove the **upgrade.from** configuration parameter from the Kafka Streams configuration.
5. Restart each consumer in the group in turn.

Additional resources

- Notable changes in 2.4.0 in the Apache Kafka documentation.

APPENDIX A. BROKER CONFIGURATION PARAMETERS

zookeeper.connect

Type: string
Importance: high
Dynamic update: read-only
Specifies the ZooKeeper connection string in the form **hostname:port** where host and port are the host and port of a ZooKeeper server. To allow connecting through other ZooKeeper nodes when that ZooKeeper machine is down you can also specify multiple hosts in the form **hostname1:port1,hostname2:port2,hostname3:port3**. The server can also have a ZooKeeper chroot path as part of its ZooKeeper connection string which puts its data under some path in the global ZooKeeper namespace. For example to give a chroot path of **/chroot/path** you would give the connection string as **hostname1:port1,hostname2:port2,hostname3:port3/chroot/path**.

advertised.host.name

Type: string
Default: null
Importance: high
Dynamic update: read-only
DEPRECATED: only used when **advertised.listeners** or **listeners** are not set. Use **advertised.listeners** instead. Hostname to publish to ZooKeeper for clients to use. In IaaS environments, this may need to be different from the interface to which the broker binds. If this is not set, it will use the value for **host.name** if configured. Otherwise it will use the value returned from java.net.InetAddress.getCanonicalHostName().

advertised.listeners

Type: string
Default: null
Importance: high
Dynamic update: per-broker
Listeners to publish to ZooKeeper for clients to use, if different than the **listeners** config property. In IaaS environments, this may need to be different from the interface to which the broker binds. If this is not set, the value for **listeners** will be used. Unlike **listeners** it is not valid to advertise the 0.0.0.0 meta-address.

advertised.port

Type: int
Default: null
Importance: high
Dynamic update: read-only
DEPRECATED: only used when **advertised.listeners** or **listeners** are not set. Use **advertised.listeners** instead. The port to publish to ZooKeeper for clients to use. In IaaS environments, this may need to be different from the port to which the broker binds. If this is not set, it will publish the same port that the broker binds to.

auto.create.topics.enable

Type: boolean
Default: true
Importance: high
Dynamic update: read-only
Enable auto creation of topic on the server.

auto.leader.rebalance.enable

Type: boolean
Default: true
Importance: high
Dynamic update: read-only
Enables auto leader balancing. A background thread checks the distribution of partition leaders at regular intervals, configurable by **leader.imbalance.check.interval.seconds**. If the leader imbalance exceeds **leader.imbalance.per.broker.percentage**, leader rebalance to the preferred leader for partitions is triggered.

background.threads

Type: int
Default: 10
Valid Values: [1,...]
Importance: high
Dynamic update: cluster-wide
The number of threads to use for various background processing tasks.

broker.id

Type: int
Default: -1
Importance: high
Dynamic update: read-only
The broker id for this server. If unset, a unique broker id will be generated.To avoid conflicts between zookeeper generated broker id's and user configured broker id's, generated broker ids start from reserved.broker.max.id + 1.

compression.type

Type: string
Default: producer
Importance: high
Dynamic update: cluster-wide
Specify the final compression type for a given topic. This configuration accepts the standard compression codecs ('gzip', 'snappy', 'lz4', 'zstd'). It additionally accepts 'uncompressed' which is equivalent to no compression; and 'producer' which means retain the original compression codec set by the producer.

control.plane.listener.name

Type: string
Default: null
Importance: high
Dynamic update: read-only
Name of listener used for communication between controller and brokers. Broker will use the control.plane.listener.name to locate the endpoint in listeners list, to listen for connections from the controller. For example, if a broker's config is : listeners = INTERNAL://192.1.1.8:9092, EXTERNAL://10.1.1.5:9093, CONTROLLER://192.1.1.8:9094 listener.security.protocol.map = INTERNAL:PLAINTEXT, EXTERNAL:SSL, CONTROLLER:SSL control.plane.listener.name = CONTROLLER On startup, the broker will start listening on "192.1.1.8:9094" with security protocol "SSL". On controller side, when it discovers a broker's published endpoints through zookeeper, it will use the control.plane.listener.name to find the endpoint, which it will use to establish connection to the broker. For example, if the broker's published endpoints on zookeeper are : "endpoints" : ["INTERNAL://broker1.example.com:9092","EXTERNAL://broker1.example.com:9093","CONTROLLER and the controller's config is : listener.security.protocol.map = INTERNAL:PLAINTEXT,

EXTERNAL:SSL, CONTROLLER:SSL control.plane.listener.name = CONTROLLER then controller will use "broker1.example.com:9094" with security protocol "SSL" to connect to the broker. If not explicitly configured, the default value will be null and there will be no dedicated endpoints for controller connections.

delete.topic.enable

Type: boolean
Default: true
Importance: high
Dynamic update: read-only
Enables delete topic. Delete topic through the admin tool will have no effect if this config is turned off.

host.name

Type: string
Default: ""
Importance: high
Dynamic update: read-only
DEPRECATED: only used when **listeners** is not set. Use **listeners** instead. hostname of broker. If this is set, it will only bind to this address. If this is not set, it will bind to all interfaces.

leader.imbalance.check.interval.seconds

Type: long
Default: 300
Importance: high
Dynamic update: read-only
The frequency with which the partition rebalance check is triggered by the controller.

leader.imbalance.per.broker.percentage

Type: int
Default: 10
Importance: high
Dynamic update: read-only
The ratio of leader imbalance allowed per broker. The controller would trigger a leader balance if it goes above this value per broker. The value is specified in percentage.

listeners

Type: string
Default: null
Importance: high
Dynamic update: per-broker
Listener List - Comma-separated list of URIs we will listen on and the listener names. If the listener name is not a security protocol, listener.security.protocol.map must also be set. Specify hostname as 0.0.0.0 to bind to all interfaces. Leave hostname empty to bind to default interface. Examples of legal listener lists: PLAINTEXT://myhost:9092,SSL://:9091 CLIENT://0.0.0.0:9092,REPLICATION://localhost:9093.

log.dir

Type: string
Default: /tmp/kafka-logs
Importance: high
Dynamic update: read-only

The directory in which the log data is kept (supplemental for log.dirs property).

log.dirs

Type: string
Default: null
Importance: high
Dynamic update: read-only
The directories in which the log data is kept. If not set, the value in log.dir is used.

log.flush.interval.messages

Type: long
Default: 9223372036854775807
Valid Values: [1,...]
Importance: high
Dynamic update: cluster-wide
The number of messages accumulated on a log partition before messages are flushed to disk.

log.flush.interval.ms

Type: long
Default: null
Importance: high
Dynamic update: cluster-wide
The maximum time in ms that a message in any topic is kept in memory before flushed to disk. If not set, the value in log.flush.scheduler.interval.ms is used.

log.flush.offset.checkpoint.interval.ms

Type: int
Default: 60000 (1 minute)
Valid Values: [0,...]
Importance: high
Dynamic update: read-only
The frequency with which we update the persistent record of the last flush which acts as the log recovery point.

log.flush.scheduler.interval.ms

Type: long
Default: 9223372036854775807
Importance: high
Dynamic update: read-only
The frequency in ms that the log flusher checks whether any log needs to be flushed to disk.

log.flush.start.offset.checkpoint.interval.ms

Type: int
Default: 60000 (1 minute)
Valid Values: [0,...]
Importance: high
Dynamic update: read-only
The frequency with which we update the persistent record of log start offset.

log.retention.bytes

Type: long

Default: -1
Importance: high
Dynamic update: cluster-wide
The maximum size of the log before deleting it.

log.retention.hours

Type: int
Default: 168
Importance: high
Dynamic update: read-only
The number of hours to keep a log file before deleting it (in hours), tertiary to log.retention.ms property.

log.retention.minutes

Type: int
Default: null
Importance: high
Dynamic update: read-only
The number of minutes to keep a log file before deleting it (in minutes), secondary to log.retention.ms property. If not set, the value in log.retention.hours is used.

log.retention.ms

Type: long
Default: null
Importance: high
Dynamic update: cluster-wide
The number of milliseconds to keep a log file before deleting it (in milliseconds), If not set, the value in log.retention.minutes is used. If set to -1, no time limit is applied.

log.roll.hours

Type: int
Default: 168
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The maximum time before a new log segment is rolled out (in hours), secondary to log.roll.ms property.

log.roll.jitter.hours

Type: int
Default: 0
Valid Values: [0,...]
Importance: high
Dynamic update: read-only
The maximum jitter to subtract from logRollTimeMillis (in hours), secondary to log.roll.jitter.ms property.

log.roll.jitter.ms

Type: long
Default: null
Importance: high
Dynamic update: cluster-wide

The maximum jitter to subtract from logRollTimeMillis (in milliseconds). If not set, the value in log.roll.jitter.hours is used.

log.roll.ms

Type: long
Default: null
Importance: high
Dynamic update: cluster-wide
The maximum time before a new log segment is rolled out (in milliseconds). If not set, the value in log.roll.hours is used.

log.segment.bytes

Type: int
Default: 1073741824 (1 gibibyte)
Valid Values: [14,...]
Importance: high
Dynamic update: cluster-wide
The maximum size of a single log file.

log.segment.delete.delay.ms

Type: long
Default: 60000 (1 minute)
Valid Values: [0,...]
Importance: high
Dynamic update: cluster-wide
The amount of time to wait before deleting a file from the filesystem.

message.max.bytes

Type: int
Default: 1048588
Valid Values: [0,...]
Importance: high
Dynamic update: cluster-wide
The largest record batch size allowed by Kafka (after compression if compression is enabled). If this is increased and there are consumers older than 0.10.2, the consumers' fetch size must also be increased so that they can fetch record batches this large. In the latest message format version, records are always grouped into batches for efficiency. In previous message format versions, uncompressed records are not grouped into batches and this limit only applies to a single record in that case.This can be set per topic with the topic level **max.message.bytes** config.

min.insync.replicas

Type: int
Default: 1
Valid Values: [1,...]
Importance: high
Dynamic update: cluster-wide
When a producer sets acks to "all" (or "-1"), min.insync.replicas specifies the minimum number of replicas that must acknowledge a write for the write to be considered successful. If this minimum cannot be met, then the producer will raise an exception (either NotEnoughReplicas or NotEnoughReplicasAfterAppend). When used together, min.insync.replicas and acks allow you to enforce greater durability guarantees. A typical scenario would be to create a topic with a replication factor of 3, set min.insync.replicas to 2, and produce with acks of "all". This will ensure that the producer raises an exception if a majority of replicas do not receive a write.

num.io.threads

Type: int
Default: 8
Valid Values: [1,...]
Importance: high
Dynamic update: cluster-wide
The number of threads that the server uses for processing requests, which may include disk I/O.

num.network.threads

Type: int
Default: 3
Valid Values: [1,...]
Importance: high
Dynamic update: cluster-wide
The number of threads that the server uses for receiving requests from the network and sending responses to the network.

num.recovery.threads.per.data.dir

Type: int
Default: 1
Valid Values: [1,...]
Importance: high
Dynamic update: cluster-wide
The number of threads per data directory to be used for log recovery at startup and flushing at shutdown.

num.replica.alter.log.dirs.threads

Type: int
Default: null
Importance: high
Dynamic update: read-only
The number of threads that can move replicas between log directories, which may include disk I/O.

num.replica.fetchers

Type: int
Default: 1
Importance: high
Dynamic update: cluster-wide
Number of fetcher threads used to replicate messages from a source broker. Increasing this value can increase the degree of I/O parallelism in the follower broker.

offset.metadata.max.bytes

Type: int
Default: 4096 (4 kibibytes)
Importance: high
Dynamic update: read-only
The maximum size for a metadata entry associated with an offset commit.

offsets.commit.required.acks

Type: short
Default: -1

Importance: high
Dynamic update: read-only
The required acks before the commit can be accepted. In general, the default (-1) should not be overridden.

offsets.commit.timeout.ms

Type: int
Default: 5000 (5 seconds)
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
Offset commit will be delayed until all replicas for the offsets topic receive the commit or this timeout is reached. This is similar to the producer request timeout.

offsets.load.buffer.size

Type: int
Default: 5242880
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
Batch size for reading from the offsets segments when loading offsets into the cache (soft-limit, overridden if records are too large).

offsets.retention.check.interval.ms

Type: long
Default: 600000 (10 minutes)
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
Frequency at which to check for stale offsets.

offsets.retention.minutes

Type: int
Default: 10080
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
After a consumer group loses all its consumers (i.e. becomes empty) its offsets will be kept for this retention period before getting discarded. For standalone consumers (using manual assignment), offsets will be expired after the time of last commit plus this retention period.

offsets.topic.compression.codec

Type: int
Default: 0
Importance: high
Dynamic update: read-only
Compression codec for the offsets topic - compression may be used to achieve "atomic" commits.

offsets.topic.num.partitions

Type: int
Default: 50
Valid Values: [1,...]

Importance: high
Dynamic update: read-only
The number of partitions for the offset commit topic (should not change after deployment).

offsets.topic.replication.factor

Type: short
Default: 3
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The replication factor for the offsets topic (set higher to ensure availability). Internal topic creation will fail until the cluster size meets this replication factor requirement.

offsets.topic.segment.bytes

Type: int
Default: 104857600 (100 mebibytes)
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The offsets topic segment bytes should be kept relatively small in order to facilitate faster log compaction and cache loads.

port

Type: int
Default: 9092
Importance: high
Dynamic update: read-only
DEPRECATED: only used when **listeners** is not set. Use **listeners** instead. the port to listen and accept connections on.

queued.max.requests

Type: int
Default: 500
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The number of queued requests allowed for data-plane, before blocking the network threads.

quota.consumer.default

Type: long
Default: 9223372036854775807
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
DEPRECATED: Used only when dynamic default quotas are not configured for <user, <client-id> or <user, client-id> in Zookeeper. Any consumer distinguished by clientId/consumer group will get throttled if it fetches more bytes than this value per-second.

quota.producer.default

Type: long
Default: 9223372036854775807
Valid Values: [1,...]

Importance: high
Dynamic update: read-only
DEPRECATED: Used only when dynamic default quotas are not configured for <user>, <client-id> or <user, client-id> in Zookeeper. Any producer distinguished by clientId will get throttled if it produces more bytes than this value per-second.

replica.fetch.min.bytes

Type: int
Default: 1
Importance: high
Dynamic update: read-only
Minimum bytes expected for each fetch response. If not enough bytes, wait up to replicaMaxWaitTimeMs.

replica.fetch.wait.max.ms

Type: int
Default: 500
Importance: high
Dynamic update: read-only
max wait time for each fetcher request issued by follower replicas. This value should always be less than the replica.lag.time.max.ms at all times to prevent frequent shrinking of ISR for low throughput topics.

replica.high.watermark.checkpoint.interval.ms

Type: long
Default: 5000 (5 seconds)
Importance: high
Dynamic update: read-only
The frequency with which the high watermark is saved out to disk.

replica.lag.time.max.ms

Type: long
Default: 30000 (30 seconds)
Importance: high
Dynamic update: read-only
If a follower hasn't sent any fetch requests or hasn't consumed up to the leaders log end offset for at least this time, the leader will remove the follower from isr.

replica.socket.receive.buffer.bytes

Type: int
Default: 65536 (64 kibibytes)
Importance: high
Dynamic update: read-only
The socket receive buffer for network requests.

replica.socket.timeout.ms

Type: int
Default: 30000 (30 seconds)
Importance: high
Dynamic update: read-only
The socket timeout for network requests. Its value should be at least replica.fetch.wait.max.ms.

request.timeout.ms

Type: int
Default: 30000 (30 seconds)
Importance: high
Dynamic update: read-only
The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

socket.receive.buffer.bytes

Type: int
Default: 102400 (100 kibibytes)
Importance: high
Dynamic update: read-only
The SO_RCVBUF buffer of the socket server sockets. If the value is -1, the OS default will be used.

socket.request.max.bytes

Type: int
Default: 104857600 (100 mebibytes)
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The maximum number of bytes in a socket request.

socket.send.buffer.bytes

Type: int
Default: 102400 (100 kibibytes)
Importance: high
Dynamic update: read-only
The SO_SNDBUF buffer of the socket server sockets. If the value is -1, the OS default will be used.

transaction.max.timeout.ms

Type: int
Default: 900000 (15 minutes)
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The maximum allowed timeout for transactions. If a client's requested transaction time exceed this, then the broker will return an error in InitProducerIdRequest. This prevents a client from too large of a timeout, which can stall consumers reading from topics included in the transaction.

transaction.state.log.load.buffer.size

Type: int
Default: 5242880
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
Batch size for reading from the transaction log segments when loading producer ids and transactions into the cache (soft-limit, overridden if records are too large).

transaction.state.log.min.isr

Type: int
Default: 2
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
Overridden min.insync.replicas config for the transaction topic.

transaction.state.log.num.partitions

Type: int
Default: 50
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The number of partitions for the transaction topic (should not change after deployment).

transaction.state.log.replication.factor

Type: short
Default: 3
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The replication factor for the transaction topic (set higher to ensure availability). Internal topic creation will fail until the cluster size meets this replication factor requirement.

transaction.state.log.segment.bytes

Type: int
Default: 104857600 (100 mebibytes)
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The transaction topic segment bytes should be kept relatively small in order to facilitate faster log compaction and cache loads.

transactional.id.expiration.ms

Type: int
Default: 604800000 (7 days)
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The time in ms that the transaction coordinator will wait without receiving any transaction status updates for the current transaction before expiring its transactional id. This setting also influences producer id expiration - producer ids are expired once this time has elapsed after the last write with the given producer id. Note that producer ids may expire sooner if the last write from the producer id is deleted due to the topic's retention settings.

unclean.leader.election.enable

Type: boolean
Default: false
Importance: high
Dynamic update: cluster-wide
Indicates whether to enable replicas not in the ISR set to be elected as leader as a last resort, even though doing so may result in data loss.

zookeeper.connection.timeout.ms

Type: int
Default: null
Importance: high
Dynamic update: read-only
The max time that the client waits to establish a connection to zookeeper. If not set, the value in zookeeper.session.timeout.ms is used.

zookeeper.max.in.flight.requests

Type: int
Default: 10
Valid Values: [1,...]
Importance: high
Dynamic update: read-only
The maximum number of unacknowledged requests the client will send to Zookeeper before blocking.

zookeeper.session.timeout.ms

Type: int
Default: 18000 (18 seconds)
Importance: high
Dynamic update: read-only
Zookeeper session timeout.

zookeeper.set.acl

Type: boolean
Default: false
Importance: high
Dynamic update: read-only
Set client to use secure ACLs.

broker.id.generation.enable

Type: boolean
Default: true
Importance: medium
Dynamic update: read-only
Enable automatic broker id generation on the server. When enabled the value configured for reserved.broker.max.id should be reviewed.

broker.rack

Type: string
Default: null
Importance: medium
Dynamic update: read-only
Rack of the broker. This will be used in rack aware replication assignment for fault tolerance. Examples: **RACK1**, **us-east-1d**.

connections.max.idle.ms

Type: long
Default: 600000 (10 minutes)
Importance: medium

Dynamic update: read-only
Idle connections timeout: the server socket processor threads close the connections that idle more than this.

connections.max.reauth.ms

Type: long
Default: 0
Importance: medium
Dynamic update: read-only
When explicitly set to a positive number (the default is 0, not a positive number), a session lifetime that will not exceed the configured value will be communicated to v2.2.0 or later clients when they authenticate. The broker will disconnect any such connection that is not re-authenticated within the session lifetime and that is then subsequently used for any purpose other than re-authentication. Configuration names can optionally be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.oauthbearer.connections.max.reauth.ms=3600000.

controlled.shutdown.enable

Type: boolean
Default: true
Importance: medium
Dynamic update: read-only
Enable controlled shutdown of the server.

controlled.shutdown.max.retries

Type: int
Default: 3
Importance: medium
Dynamic update: read-only
Controlled shutdown can fail for multiple reasons. This determines the number of retries when such failure happens.

controlled.shutdown.retry.backoff.ms

Type: long
Default: 5000 (5 seconds)
Importance: medium
Dynamic update: read-only
Before each retry, the system needs time to recover from the state that caused the previous failure (Controller fail over, replica lag etc). This config determines the amount of time to wait before retrying.

controller.socket.timeout.ms

Type: int
Default: 30000 (30 seconds)
Importance: medium
Dynamic update: read-only
The socket timeout for controller-to-broker channels.

default.replication.factor

Type: int
Default: 1
Importance: medium
Dynamic update: read-only

default replication factors for automatically created topics.

delegation.token.expiry.time.ms

Type: long
Default: 86400000 (1 day)
Valid Values: [1,...]
Importance: medium
Dynamic update: read-only
The token validity time in miliseconds before the token needs to be renewed. Default value 1 day.

delegation.token.master.key

Type: password
Default: null
Importance: medium
Dynamic update: read-only
Master/secret key to generate and verify delegation tokens. Same key must be configured across all the brokers. If the key is not set or set to empty string, brokers will disable the delegation token support.

delegation.token.max.lifetime.ms

Type: long
Default: 604800000 (7 days)
Valid Values: [1,...]
Importance: medium
Dynamic update: read-only
The token has a maximum lifetime beyond which it cannot be renewed anymore. Default value 7 days.

delete.records.purgatory.purge.interval.requests

Type: int
Default: 1
Importance: medium
Dynamic update: read-only
The purge interval (in number of requests) of the delete records request purgatory.

fetch.max.bytes

Type: int
Default: 57671680 (55 mebibytes)
Valid Values: [1024,...]
Importance: medium
Dynamic update: read-only
The maximum number of bytes we will return for a fetch request. Must be at least 1024.

fetch.purgatory.purge.interval.requests

Type: int
Default: 1000
Importance: medium
Dynamic update: read-only
The purge interval (in number of requests) of the fetch request purgatory.

group.initial.rebalance.delay.ms

Type: int
Default: 3000 (3 seconds)
Importance: medium
Dynamic update: read-only
The amount of time the group coordinator will wait for more consumers to join a new group before performing the first rebalance. A longer delay means potentially fewer rebalances, but increases the time until processing begins.

group.max.session.timeout.ms

Type: int
Default: 1800000 (30 minutes)
Importance: medium
Dynamic update: read-only
The maximum allowed session timeout for registered consumers. Longer timeouts give consumers more time to process messages in between heartbeats at the cost of a longer time to detect failures.

group.max.size

Type: int
Default: 2147483647
Valid Values: [1,...]
Importance: medium
Dynamic update: read-only
The maximum number of consumers that a single consumer group can accommodate.

group.min.session.timeout.ms

Type: int
Default: 6000 (6 seconds)
Importance: medium
Dynamic update: read-only
The minimum allowed session timeout for registered consumers. Shorter timeouts result in quicker failure detection at the cost of more frequent consumer heartbeating, which can overwhelm broker resources.

inter.broker.listener.name

Type: string
Default: null
Importance: medium
Dynamic update: read-only
Name of listener used for communication between brokers. If this is unset, the listener name is defined by security.inter.broker.protocol. It is an error to set this and security.inter.broker.protocol properties at the same time.

inter.broker.protocol.version

Type: string
Default: 2.6-IV0
Valid Values: [0.8.0, 0.8.1, 0.8.2, 0.9.0, 0.10.0-IV0, 0.10.0-IV1, 0.10.1-IV0, 0.10.1-IV1, 0.10.1-IV2, 0.10.2-IV0, 0.11.0-IV0, 0.11.0-IV1, 0.11.0-IV2, 1.0-IV0, 1.1-IV0, 2.0-IV0, 2.0-IV1, 2.1-IV0, 2.1-IV1, 2.1-IV2, 2.2-IV0, 2.2-IV1, 2.3-IV0, 2.3-IV1, 2.4-IV0, 2.4-IV1, 2.5-IV0, 2.6-IV0]
Importance: medium
Dynamic update: read-only

Specify which version of the inter-broker protocol will be used. This is typically bumped after all brokers were upgraded to a new version. Example of some valid values are: 0.8.0, 0.8.1, 0.8.1.1, 0.8.2, 0.8.2.0, 0.8.2.1, 0.9.0.0, 0.9.0.1 Check ApiVersion for the full list.

log.cleaner.backoff.ms

Type: long
Default: 15000 (15 seconds)
Valid Values: [0,...]
Importance: medium
Dynamic update: cluster-wide
The amount of time to sleep when there are no logs to clean.

log.cleaner.dedupe.buffer.size

Type: long
Default: 134217728
Importance: medium
Dynamic update: cluster-wide
The total memory used for log deduplication across all cleaner threads.

log.cleaner.delete.retention.ms

Type: long
Default: 86400000 (1 day)
Importance: medium
Dynamic update: cluster-wide
How long are delete records retained?

log.cleaner.enable

Type: boolean
Default: true
Importance: medium
Dynamic update: read-only
Enable the log cleaner process to run on the server. Should be enabled if using any topics with a cleanup.policy=compact including the internal offsets topic. If disabled those topics will not be compacted and continually grow in size.

log.cleaner.io.buffer.load.factor

Type: double
Default: 0.9
Importance: medium
Dynamic update: cluster-wide
Log cleaner dedupe buffer load factor. The percentage full the dedupe buffer can become. A higher value will allow more log to be cleaned at once but will lead to more hash collisions.

log.cleaner.io.buffer.size

Type: int
Default: 524288
Valid Values: [0,...]
Importance: medium
Dynamic update: cluster-wide
The total memory used for log cleaner I/O buffers across all cleaner threads.

log.cleaner.io.max.bytes.per.second

Type: double
Default: 1.7976931348623157E308
Importance: medium
Dynamic update: cluster-wide
The log cleaner will be throttled so that the sum of its read and write i/o will be less than this value on average.

log.cleaner.max.compaction.lag.ms

Type: long
Default: 9223372036854775807
Importance: medium
Dynamic update: cluster-wide
The maximum time a message will remain ineligible for compaction in the log. Only applicable for logs that are being compacted.

log.cleaner.min.cleanable.ratio

Type: double
Default: 0.5
Importance: medium
Dynamic update: cluster-wide
The minimum ratio of dirty log to total log for a log to eligible for cleaning. If the log.cleaner.max.compaction.lag.ms or the log.cleaner.min.compaction.lag.ms configurations are also specified, then the log compactor considers the log eligible for compaction as soon as either: (i) the dirty ratio threshold has been met and the log has had dirty (uncompacted) records for at least the log.cleaner.min.compaction.lag.ms duration, or (ii) if the log has had dirty (uncompacted) records for at most the log.cleaner.max.compaction.lag.ms period.

log.cleaner.min.compaction.lag.ms

Type: long
Default: 0
Importance: medium
Dynamic update: cluster-wide
The minimum time a message will remain uncompacted in the log. Only applicable for logs that are being compacted.

log.cleaner.threads

Type: int
Default: 1
Valid Values: [0,...]
Importance: medium
Dynamic update: cluster-wide
The number of background threads to use for log cleaning.

log.cleanup.policy

Type: list
Default: delete
Valid Values: [compact, delete]
Importance: medium
Dynamic update: cluster-wide
The default cleanup policy for segments beyond the retention window. A comma separated list of valid policies. Valid policies are: "delete" and "compact".

log.index.interval.bytes

Type: int
Default: 4096 (4 kibibytes)
Valid Values: [0,...]
Importance: medium
Dynamic update: cluster-wide
The interval with which we add an entry to the offset index.

log.index.size.max.bytes

Type: int
Default: 10485760 (10 mebibytes)
Valid Values: [4,...]
Importance: medium
Dynamic update: cluster-wide
The maximum size in bytes of the offset index.

log.message.format.version

Type: string
Default: 2.6-IV0
Valid Values: [0.8.0, 0.8.1, 0.8.2, 0.9.0, 0.10.0-IV0, 0.10.0-IV1, 0.10.1-IV0, 0.10.1-IV1, 0.10.1-IV2, 0.10.2-IV0, 0.11.0-IV0, 0.11.0-IV1, 0.11.0-IV2, 1.0-IV0, 1.1-IV0, 2.0-IV0, 2.0-IV1, 2.1-IV0, 2.1-IV1, 2.1-IV2, 2.2-IV0, 2.2-IV1, 2.3-IV0, 2.3-IV1, 2.4-IV0, 2.4-IV1, 2.5-IV0, 2.6-IV0]
Importance: medium
Dynamic update: read-only
Specify the message format version the broker will use to append messages to the logs. The value should be a valid ApiVersion. Some examples are: 0.8.2, 0.9.0.0, 0.10.0, check ApiVersion for more details. By setting a particular message format version, the user is certifying that all the existing messages on disk are smaller or equal than the specified version. Setting this value incorrectly will cause consumers with older versions to break as they will receive messages with a format that they don't understand.

log.message.timestamp.difference.max.ms

Type: long
Default: 9223372036854775807
Importance: medium
Dynamic update: cluster-wide
The maximum difference allowed between the timestamp when a broker receives a message and the timestamp specified in the message. If log.message.timestamp.type=CreateTime, a message will be rejected if the difference in timestamp exceeds this threshold. This configuration is ignored if log.message.timestamp.type=LogAppendTime.The maximum timestamp difference allowed should be no greater than log.retention.ms to avoid unnecessarily frequent log rolling.

log.message.timestamp.type

Type: string
Default: CreateTime
Valid Values: [CreateTime, LogAppendTime]
Importance: medium
Dynamic update: cluster-wide
Define whether the timestamp in the message is message create time or log append time. The value should be either **CreateTime** or **LogAppendTime**.

log.preallocate

Type: boolean
Default: false
Importance: medium
Dynamic update: cluster-wide
Should pre allocate file when create new segment? If you are using Kafka on Windows, you probably need to set it to true.

log.retention.check.interval.ms

Type: long
Default: 300000 (5 minutes)
Valid Values: [1,...]
Importance: medium
Dynamic update: read-only
The frequency in milliseconds that the log cleaner checks whether any log is eligible for deletion.

max.connections

Type: int
Default: 2147483647
Valid Values: [0,...]
Importance: medium
Dynamic update: cluster-wide
The maximum number of connections we allow in the broker at any time. This limit is applied in addition to any per-ip limits configured using max.connections.per.ip. Listener-level limits may also be configured by prefixing the config name with the listener prefix, for example, **listener.name.internal.max.connections**. Broker-wide limit should be configured based on broker capacity while listener limits should be configured based on application requirements. New connections are blocked if either the listener or broker limit is reached. Connections on the inter-broker listener are permitted even if broker-wide limit is reached. The least recently used connection on another listener will be closed in this case.

max.connections.per.ip

Type: int
Default: 2147483647
Valid Values: [0,...]
Importance: medium
Dynamic update: cluster-wide
The maximum number of connections we allow from each ip address. This can be set to 0 if there are overrides configured using max.connections.per.ip.overrides property. New connections from the ip address are dropped if the limit is reached.

max.connections.per.ip.overrides

Type: string
Default: ""
Importance: medium
Dynamic update: cluster-wide
A comma-separated list of per-ip or hostname overrides to the default maximum number of connections. An example value is "hostName:100,127.0.0.1:200".

max.incremental.fetch.session.cache.slots

Type: int
Default: 1000
Valid Values: [0,...]

Importance: medium
Dynamic update: read-only
The maximum number of incremental fetch sessions that we will maintain.

num.partitions

Type: int
Default: 1
Valid Values: [1,...]
Importance: medium
Dynamic update: read-only
The default number of log partitions per topic.

password.encoder.old.secret

Type: password
Default: null
Importance: medium
Dynamic update: read-only
The old secret that was used for encoding dynamically configured passwords. This is required only when the secret is updated. If specified, all dynamically encoded passwords are decoded using this old secret and re-encoded using password.encoder.secret when broker starts up.

password.encoder.secret

Type: password
Default: null
Importance: medium
Dynamic update: read-only
The secret used for encoding dynamically configured passwords for this broker.

principal.builder.class

Type: class
Default: null
Importance: medium
Dynamic update: per-broker
The fully qualified name of a class that implements the KafkaPrincipalBuilder interface, which is used to build the KafkaPrincipal object used during authorization. This config also supports the deprecated PrincipalBuilder interface which was previously used for client authentication over SSL. If no principal builder is defined, the default behavior depends on the security protocol in use. For SSL authentication, the principal will be derived using the rules defined by **ssl.principal.mapping.rules** applied on the distinguished name from the client certificate if one is provided; otherwise, if client authentication is not required, the principal name will be ANONYMOUS. For SASL authentication, the principal will be derived using the rules defined by **sasl.kerberos.principal.to.local.rules** if GSSAPI is in use, and the SASL authentication ID for other mechanisms. For PLAINTEXT, the principal will be ANONYMOUS.

producer.purgatory.purge.interval.requests

Type: int
Default: 1000
Importance: medium
Dynamic update: read-only
The purge interval (in number of requests) of the producer request purgatory.

queued.max.request.bytes

Type: long
Default: -1
Importance: medium
Dynamic update: read-only
The number of queued bytes allowed before no more requests are read.

replica.fetch.backoff.ms

Type: int
Default: 1000 (1 second)
Valid Values: [0,...]
Importance: medium
Dynamic update: read-only
The amount of time to sleep when fetch partition error occurs.

replica.fetch.max.bytes

Type: int
Default: 1048576 (1 mebibyte)
Valid Values: [0,...]
Importance: medium
Dynamic update: read-only
The number of bytes of messages to attempt to fetch for each partition. This is not an absolute maximum, if the first record batch in the first non-empty partition of the fetch is larger than this value, the record batch will still be returned to ensure that progress can be made. The maximum record batch size accepted by the broker is defined via **message.max.bytes** (broker config) or **max.message.bytes** (topic config).

replica.fetch.response.max.bytes

Type: int
Default: 10485760 (10 mebibytes)
Valid Values: [0,...]
Importance: medium
Dynamic update: read-only
Maximum bytes expected for the entire fetch response. Records are fetched in batches, and if the first record batch in the first non-empty partition of the fetch is larger than this value, the record batch will still be returned to ensure that progress can be made. As such, this is not an absolute maximum. The maximum record batch size accepted by the broker is defined via **message.max.bytes** (broker config) or **max.message.bytes** (topic config).

replica.selector.class

Type: string
Default: null
Importance: medium
Dynamic update: read-only
The fully qualified class name that implements ReplicaSelector. This is used by the broker to find the preferred read replica. By default, we use an implementation that returns the leader.

reserved.broker.max.id

Type: int
Default: 1000
Valid Values: [0,...]
Importance: medium
Dynamic update: read-only

Max number that can be used for a broker.id.

sasl.client.callback.handler.class

Type: class
Default: null
Importance: medium
Dynamic update: read-only
The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

sasl.enabled.mechanisms

Type: list
Default: GSSAPI
Importance: medium
Dynamic update: per-broker
The list of SASL mechanisms enabled in the Kafka server. The list may contain any mechanism for which a security provider is available. Only GSSAPI is enabled by default.

sasl.jaas.config

Type: password
Default: null
Importance: medium
Dynamic update: per-broker
JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: 'loginModuleClass controlFlag (optionName=optionValue)*;'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;.

sasl.kerberos.kinit.cmd

Type: string
Default: /usr/bin/kinit
Importance: medium
Dynamic update: per-broker
Kerberos kinit command path.

sasl.kerberos.min.time.before.relogin

Type: long
Default: 60000
Importance: medium
Dynamic update: per-broker
Login thread sleep time between refresh attempts.

sasl.kerberos.principal.to.local.rules

Type: list
Default: DEFAULT
Importance: medium
Dynamic update: per-broker
A list of rules for mapping from principal names to short names (typically operating system usernames). The rules are evaluated in order and the first rule that matches a principal name is used to map it to a short name. Any later rules in the list are ignored. By default, principal names of the

form {username}/{hostname}@{REALM} are mapped to {username}. For more details on the format please see security authorization and acls. Note that this configuration is ignored if an extension of KafkaPrincipalBuilder is provided by the **principal.builder.class** configuration.

sasl.kerberos.service.name

Type: string
Default: null
Importance: medium
Dynamic update: per-broker
The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

sasl.kerberos.ticket.renew.jitter

Type: double
Default: 0.05
Importance: medium
Dynamic update: per-broker
Percentage of random jitter added to the renewal time.

sasl.kerberos.ticket.renew.window.factor

Type: double
Default: 0.8
Importance: medium
Dynamic update: per-broker
Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

sasl.login.callback.handler.class

Type: class
Default: null
Importance: medium
Dynamic update: read-only
The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler.

sasl.login.class

Type: class
Default: null
Importance: medium
Dynamic update: read-only
The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin.

sasl.login.refresh.buffer.seconds

Type: short
Default: 300
Importance: medium
Dynamic update: per-broker

The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.min.period.seconds

Type: short
Default: 60
Importance: medium
Dynamic update: per-broker
The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.factor

Type: double
Default: 0.8
Importance: medium
Dynamic update: per-broker
Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.jitter

Type: double
Default: 0.05
Importance: medium
Dynamic update: per-broker
The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

sasl.mechanism.inter.broker.protocol

Type: string
Default: GSSAPI
Importance: medium
Dynamic update: per-broker
SASL mechanism used for inter-broker communication. Default is GSSAPI.

sasl.server.callback.handler.class

Type: class
Default: null
Importance: medium
Dynamic update: read-only
The fully qualified name of a SASL server callback handler class that implements the AuthenticateCallbackHandler interface. Server callback handlers must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.plain.sasl.server.callback.handler.class=com.example.CustomPlainCallbackHandler

security.inter.broker.protocol

Type: string
Default: PLAINTEXT
Importance: medium
Dynamic update: read-only
Security protocol used to communicate between brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL. It is an error to set this and inter.broker.listener.name properties at the same time.

ssl.cipher.suites

Type: list
Default: ""
Importance: medium
Dynamic update: per-broker
A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

ssl.client.auth

Type: string
Default: none
Valid Values: [required, requested, none]
Importance: medium
Dynamic update: per-broker
Configures kafka broker to request client authentication. The following settings are common:

- **ssl.client.auth=required** If set to required client authentication is required.
- **ssl.client.auth=requested** This means client authentication is optional. unlike requested , if this option is set client can choose not to provide authentication information about itself
- **ssl.client.auth=none** This means client authentication is not needed.

ssl.enabled.protocols

Type: list
Default: TLSv1.2,TLSv1.3
Importance: medium
Dynamic update: per-broker
The list of protocols enabled for SSL connections. The default is 'TLSv1.2,TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. With the default value for Java 11, clients and servers will prefer TLSv1.3 if both support it and fallback to TLSv1.2 otherwise (assuming both support at least TLSv1.2). This default should be fine for most cases. Also see the config documentation for **ssl.protocol**.

ssl.key.password

Type: password
Default: null
Importance: medium
Dynamic update: per-broker
The password of the private key in the key store file. This is optional for client.

ssl.keymanager.algorithm

Type: string

Default: SunX509
Importance: medium
Dynamic update: per-broker
The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

ssl.keystore.location

Type: string
Default: null
Importance: medium
Dynamic update: per-broker
The location of the key store file. This is optional for client and can be used for two-way authentication for client.

ssl.keystore.password

Type: password
Default: null
Importance: medium
Dynamic update: per-broker
The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

ssl.keystore.type

Type: string
Default: JKS
Importance: medium
Dynamic update: per-broker
The file format of the key store file. This is optional for client.

ssl.protocol

Type: string
Default: TLSv1.3
Importance: medium
Dynamic update: per-broker
The SSL protocol used to generate the SSLContext. The default is 'TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. This value should be fine for most use cases. Allowed values in recent JVMs are 'TLSv1.2' and 'TLSv1.3'. 'TLS', 'TLSv1.1', 'SSL', 'SSLv2' and 'SSLv3' may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities. With the default value for this config and 'ssl.enabled.protocols', clients will downgrade to 'TLSv1.2' if the server does not support 'TLSv1.3'. If this config is set to 'TLSv1.2', clients will not use 'TLSv1.3' even if it is one of the values in ssl.enabled.protocols and the server only supports 'TLSv1.3'.

ssl.provider

Type: string
Default: null
Importance: medium
Dynamic update: per-broker
The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

ssl.trustmanager.algorithm

Type: string

Default: PKIX
Importance: medium
Dynamic update: per-broker
The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

ssl.truststore.location

Type: string
Default: null
Importance: medium
Dynamic update: per-broker
The location of the trust store file.

ssl.truststore.password

Type: password
Default: null
Importance: medium
Dynamic update: per-broker
The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

ssl.truststore.type

Type: string
Default: JKS
Importance: medium
Dynamic update: per-broker
The file format of the trust store file.

zookeeper.clientCnxnSocket

Type: string
Default: null
Importance: medium
Dynamic update: read-only
Typically set to **org.apache.zookeeper.ClientCnxnSocketNetty** when using TLS connectivity to ZooKeeper. Overrides any explicit value set via the same-named **zookeeper.clientCnxnSocket** system property.

zookeeper.ssl.client.enable

Type: boolean
Default: false
Importance: medium
Dynamic update: read-only
Set client to use TLS when connecting to ZooKeeper. An explicit value overrides any value set via the **zookeeper.client.secure** system property (note the different name). Defaults to false if neither is set; when true, **zookeeper.clientCnxnSocket** must be set (typically to **org.apache.zookeeper.ClientCnxnSocketNetty**); other values to set may include **zookeeper.ssl.cipher.suites**, **zookeeper.ssl.crl.enable**, **zookeeper.ssl.enabled.protocols**, **zookeeper.ssl.endpoint.identification.algorithm**, **zookeeper.ssl.keystore.location**, **zookeeper.ssl.keystore.password**, **zookeeper.ssl.keystore.type**, **zookeeper.ssl.ocsp.enable**, **zookeeper.ssl.protocol**, **zookeeper.ssl.truststore.location**, **zookeeper.ssl.truststore.password**, **zookeeper.ssl.truststore.type**.

zookeeper.ssl.keystore.location

Type: string
Default: null
Importance: medium
Dynamic update: read-only
Keystore location when using a client-side certificate with TLS connectivity to ZooKeeper. Overrides any explicit value set via the **zookeeper.ssl.keyStore.location** system property (note the camelCase).

zookeeper.ssl.keystore.password

Type: password
Default: null
Importance: medium
Dynamic update: read-only
Keystore password when using a client-side certificate with TLS connectivity to ZooKeeper. Overrides any explicit value set via the **zookeeper.ssl.keyStore.password** system property (note the camelCase). Note that ZooKeeper does not support a key password different from the keystore password, so be sure to set the key password in the keystore to be identical to the keystore password; otherwise the connection attempt to Zookeeper will fail.

zookeeper.ssl.keystore.type

Type: string
Default: null
Importance: medium
Dynamic update: read-only
Keystore type when using a client-side certificate with TLS connectivity to ZooKeeper. Overrides any explicit value set via the **zookeeper.ssl.keyStore.type** system property (note the camelCase). The default value of **null** means the type will be auto-detected based on the filename extension of the keystore.

zookeeper.ssl.truststore.location

Type: string
Default: null
Importance: medium
Dynamic update: read-only
Truststore location when using TLS connectivity to ZooKeeper. Overrides any explicit value set via the **zookeeper.ssl.trustStore.location** system property (note the camelCase).

zookeeper.ssl.truststore.password

Type: password
Default: null
Importance: medium
Dynamic update: read-only
Truststore password when using TLS connectivity to ZooKeeper. Overrides any explicit value set via the **zookeeper.ssl.trustStore.password** system property (note the camelCase).

zookeeper.ssl.truststore.type

Type: string
Default: null
Importance: medium
Dynamic update: read-only

Truststore type when using TLS connectivity to ZooKeeper. Overrides any explicit value set via the **zookeeper.ssl.trustStore.type** system property (note the camelCase). The default value of **null** means the type will be auto-detected based on the filename extension of the truststore.

alter.config.policy.class.name

Type: class
Default: null
Importance: low
Dynamic update: read-only
The alter configs policy class that should be used for validation. The class should implement the **org.apache.kafka.server.policy.AlterConfigPolicy** interface.

alter.log.dirs.replication.quota.window.num

Type: int
Default: 11
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The number of samples to retain in memory for alter log dirs replication quotas.

alter.log.dirs.replication.quota.window.size.seconds

Type: int
Default: 1
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The time span of each sample for alter log dirs replication quotas.

authorizer.class.name

Type: string
Default: ""
Importance: low
Dynamic update: read-only
The fully qualified name of a class that implements sorg.apache.kafka.server.authorizer.Authorizer interface, which is used by the broker for authorization. This config also supports authorizers that implement the deprecated kafka.security.auth.Authorizer trait which was previously used for authorization.

client.quota.callback.class

Type: class
Default: null
Importance: low
Dynamic update: read-only
The fully qualified name of a class that implements the ClientQuotaCallback interface, which is used to determine quota limits applied to client requests. By default, <user, client-id>, <user> or <client-id> quotas stored in ZooKeeper are applied. For any given request, the most specific quota that matches the user principal of the session and the client-id of the request is applied.

connection.failed.authentication.delay.ms

Type: int
Default: 100
Valid Values: [0,...]

Importance: low
Dynamic update: read-only
Connection close delay on failed authentication: this is the time (in milliseconds) by which connection close will be delayed on authentication failure. This must be configured to be less than connections.max.idle.ms to prevent connection timeout.

create.topic.policy.class.name

Type: class
Default: null
Importance: low
Dynamic update: read-only
The create topic policy class that should be used for validation. The class should implement the **org.apache.kafka.server.policy.CreateTopicPolicy** interface.

delegation.token.expiry.check.interval.ms

Type: long
Default: 3600000 (1 hour)
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
Scan interval to remove expired delegation tokens.

kafka.metrics.polling.interval.secs

Type: int
Default: 10
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The metrics polling interval (in seconds) which can be used in kafka.metrics.reporters implementations.

kafka.metrics.reporters

Type: list
Default: ""
Importance: low
Dynamic update: read-only
A list of classes to use as Yammer metrics custom reporters. The reporters should implement **kafka.metrics.KafkaMetricsReporter** trait. If a client wants to expose JMX operations on a custom reporter, the custom reporter needs to additionally implement an MBean trait that extends **kafka.metrics.KafkaMetricsReporterMBean** trait so that the registered MBean is compliant with the standard MBean convention.

listener.security.protocol.map

Type: string
Default:
PLAINTEXT:PLAINTEXT,SSL:SSL,SASL_PLAINTEXT:SASL_PLAINTEXT,SASL_SSL:SASL_SSL
Importance: low
Dynamic update: per-broker
Map between listener names and security protocols. This must be defined for the same security protocol to be usable in more than one port or IP. For example, internal and external traffic can be separated even if SSL is required for both. Concretely, the user could define listeners with names INTERNAL and EXTERNAL and this property as: **INTERNAL:SSL,EXTERNAL:SSL**. As shown, key

and value are separated by a colon and map entries are separated by commas. Each listener name should only appear once in the map. Different security (SSL and SASL) settings can be configured for each listener by adding a normalised prefix (the listener name is lowercased) to the config name. For example, to set a different keystore for the INTERNAL listener, a config with name **listener.name.internal.ssl.keystore.location** would be set. If the config for the listener name is not set, the config will fallback to the generic config (i.e. **ssl.keystore.location**).

log.message.downconversion.enable

Type: boolean
Default: true
Importance: low
Dynamic update: cluster-wide
This configuration controls whether down-conversion of message formats is enabled to satisfy consume requests. When set to **false**, broker will not perform down-conversion for consumers expecting an older message format. The broker responds with **UNSUPPORTED_VERSION** error for consume requests from such older clients. This configurationdoes not apply to any message format conversion that might be required for replication to followers.

metric.reporters

Type: list
Default: ""
Importance: low
Dynamic update: cluster-wide
A list of classes to use as metrics reporters. Implementing the **org.apache.kafka.common.metrics.MetricsReporter** interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

metrics.num.samples

Type: int
Default: 2
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The number of samples maintained to compute metrics.

metrics.recording.level

Type: string
Default: INFO
Importance: low
Dynamic update: read-only
The highest recording level for metrics.

metrics.sample.window.ms

Type: long
Default: 30000 (30 seconds)
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The window of time a metrics sample is computed over.

password.encoder.cipher.algorithm

Type: string

Default: AES/CBC/PKCS5Padding
Importance: low
Dynamic update: read-only
The Cipher algorithm used for encoding dynamically configured passwords.

password.encoder.iterations

Type: int
Default: 4096
Valid Values: [1024,...]
Importance: low
Dynamic update: read-only
The iteration count used for encoding dynamically configured passwords.

password.encoder.key.length

Type: int
Default: 128
Valid Values: [8,...]
Importance: low
Dynamic update: read-only
The key length used for encoding dynamically configured passwords.

password.encoder.keyfactory.algorithm

Type: string
Default: null
Importance: low
Dynamic update: read-only
The SecretKeyFactory algorithm used for encoding dynamically configured passwords. Default is PBKDF2WithHmacSHA512 if available and PBKDF2WithHmacSHA1 otherwise.

quota.window.num

Type: int
Default: 11
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The number of samples to retain in memory for client quotas.

quota.window.size.seconds

Type: int
Default: 1
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The time span of each sample for client quotas.

replication.quota.window.num

Type: int
Default: 11
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The number of samples to retain in memory for replication quotas.

replication.quota.window.size.seconds

Type: int
Default: 1
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The time span of each sample for replication quotas.

security.providers

Type: string
Default: null
Importance: low
Dynamic update: read-only
A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the **org.apache.kafka.common.security.auth.SecurityProviderCreator** interface.

ssl.endpoint.identification.algorithm

Type: string
Default: https
Importance: low
Dynamic update: per-broker
The endpoint identification algorithm to validate server hostname using server certificate.

ssl.engine.factory.class

Type: class
Default: null
Importance: low
Dynamic update: per-broker
The class of type org.apache.kafka.common.security.auth.SslEngineFactory to provide SSLEngine objects. Default value is org.apache.kafka.common.security.ssl.DefaultSslEngineFactory.

ssl.principal.mapping.rules

Type: string
Default: DEFAULT
Importance: low
Dynamic update: read-only
A list of rules for mapping from distinguished name from the client certificate to short name. The rules are evaluated in order and the first rule that matches a principal name is used to map it to a short name. Any later rules in the list are ignored. By default, distinguished name of the X.500 certificate will be the principal. For more details on the format please see security authorization and acls. Note that this configuration is ignored if an extension of KafkaPrincipalBuilder is provided by the **principal.builder.class** configuration.

ssl.secure.random.implementation

Type: string
Default: null
Importance: low
Dynamic update: per-broker
The SecureRandom PRNG implementation to use for SSL cryptography operations.

transaction.abort.timed.out.transaction.cleanup.interval.ms

Type: int
Default: 10000 (10 seconds)
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The interval at which to rollback transactions that have timed out.

transaction.remove.expired.transaction.cleanup.interval.ms

Type: int
Default: 3600000 (1 hour)
Valid Values: [1,...]
Importance: low
Dynamic update: read-only
The interval at which to remove transactions that have expired due to **transactional.id.expiration.ms** passing.

zookeeper.ssl.cipher.suites

Type: list
Default: null
Importance: low
Dynamic update: read-only
Specifies the enabled cipher suites to be used in ZooKeeper TLS negotiation (csv). Overrides any explicit value set via the **zookeeper.ssl.ciphersuites** system property (note the single word "ciphersuites"). The default value of **null** means the list of enabled cipher suites is determined by the Java runtime being used.

zookeeper.ssl.crl.enable

Type: boolean
Default: false
Importance: low
Dynamic update: read-only
Specifies whether to enable Certificate Revocation List in the ZooKeeper TLS protocols. Overrides any explicit value set via the **zookeeper.ssl.crl** system property (note the shorter name).

zookeeper.ssl.enabled.protocols

Type: list
Default: null
Importance: low
Dynamic update: read-only
Specifies the enabled protocol(s) in ZooKeeper TLS negotiation (csv). Overrides any explicit value set via the **zookeeper.ssl.enabledProtocols** system property (note the camelCase). The default value of **null** means the enabled protocol will be the value of the **zookeeper.ssl.protocol** configuration property.

zookeeper.ssl.endpoint.identification.algorithm

Type: string
Default: HTTPS
Importance: low
Dynamic update: read-only
Specifies whether to enable hostname verification in the ZooKeeper TLS negotiation process, with (case-insensitively) "https" meaning ZooKeeper hostname verification is enabled and an explicit blank value meaning it is disabled (disabling it is only recommended for testing purposes). An explicit

value overrides any "true" or "false" value set via the **zookeeper.ssl.hostnameVerification** system property (note the different name and values; true implies https and false implies blank).

zookeeper.ssl.ocsp.enable

Type: boolean
Default: false
Importance: low
Dynamic update: read-only
Specifies whether to enable Online Certificate Status Protocol in the ZooKeeper TLS protocols. Overrides any explicit value set via the **zookeeper.ssl.ocsp** system property (note the shorter name).

zookeeper.ssl.protocol

Type: string
Default: TLSv1.2
Importance: low
Dynamic update: read-only
Specifies the protocol to be used in ZooKeeper TLS negotiation. An explicit value overrides any value set via the same-named **zookeeper.ssl.protocol** system property.

zookeeper.sync.time.ms

Type: int
Default: 2000 (2 seconds)
Importance: low
Dynamic update: read-only
How far a ZK follower can be behind a ZK leader.

APPENDIX B. TOPIC CONFIGURATION PARAMETERS

cleanup.policy

Type: list
Default: delete
Valid Values: [compact, delete]
Server Default Property: log.cleanup.policy
Importance: medium
A string that is either "delete" or "compact" or both. This string designates the retention policy to use on old log segments. The default policy ("delete") will discard old segments when their retention time or size limit has been reached. The "compact" setting will enable log compaction on the topic.

compression.type

Type: string
Default: producer
Valid Values: [uncompressed, zstd, lz4, snappy, gzip, producer]
Server Default Property: compression.type
Importance: medium
Specify the final compression type for a given topic. This configuration accepts the standard compression codecs ('gzip', 'snappy', 'lz4', 'zstd'). It additionally accepts 'uncompressed' which is equivalent to no compression; and 'producer' which means retain the original compression codec set by the producer.

delete.retention.ms

Type: long
Default: 86400000 (1 day)
Valid Values: [0,...]
Server Default Property: log.cleaner.delete.retention.ms
Importance: medium
The amount of time to retain delete tombstone markers for log compacted topics. This setting also gives a bound on the time in which a consumer must complete a read if they begin from offset 0 to ensure that they get a valid snapshot of the final stage (otherwise delete tombstones may be collected before they complete their scan).

file.delete.delay.ms

Type: long
Default: 60000 (1 minute)
Valid Values: [0,...]
Server Default Property: log.segment.delete.delay.ms
Importance: medium
The time to wait before deleting a file from the filesystem.

flush.messages

Type: long
Default: 9223372036854775807
Valid Values: [0,...]
Server Default Property: log.flush.interval.messages
Importance: medium
This setting allows specifying an interval at which we will force an fsync of data written to the log. For example if this was set to 1 we would fsync after every message; if it were 5 we would fsync after every five messages. In general we recommend you not set this and use replication for durability and

allow the operating system's background flush capabilities as it is more efficient. This setting can be overridden on a per-topic basis (see the per-topic configuration section).

flush.ms

Type: long
Default: 9223372036854775807
Valid Values: [0,...]
Server Default Property: log.flush.interval.ms
Importance: medium
This setting allows specifying a time interval at which we will force an fsync of data written to the log. For example if this was set to 1000 we would fsync after 1000 ms had passed. In general we recommend you not set this and use replication for durability and allow the operating system's background flush capabilities as it is more efficient.

follower.replication.throttled.replicas

Type: list
Default: ""
Valid Values: [partitionId]:[brokerId],[partitionId]:[brokerId],...
Server Default Property: follower.replication.throttled.replicas
Importance: medium
A list of replicas for which log replication should be throttled on the follower side. The list should describe a set of replicas in the form [PartitionId]:[BrokerId],[PartitionId]:[BrokerId]:... or alternatively the wildcard '*' can be used to throttle all replicas for this topic.

index.interval.bytes

Type: int
Default: 4096 (4 kibibytes)
Valid Values: [0,...]
Server Default Property: log.index.interval.bytes
Importance: medium
This setting controls how frequently Kafka adds an index entry to its offset index. The default setting ensures that we index a message roughly every 4096 bytes. More indexing allows reads to jump closer to the exact position in the log but makes the index larger. You probably don't need to change this.

leader.replication.throttled.replicas

Type: list
Default: ""
Valid Values: [partitionId]:[brokerId],[partitionId]:[brokerId],...
Server Default Property: leader.replication.throttled.replicas
Importance: medium
A list of replicas for which log replication should be throttled on the leader side. The list should describe a set of replicas in the form [PartitionId]:[BrokerId],[PartitionId]:[BrokerId]:... or alternatively the wildcard '*' can be used to throttle all replicas for this topic.

max.compaction.lag.ms

Type: long
Default: 9223372036854775807
Valid Values: [1,...]
Server Default Property: log.cleaner.max.compaction.lag.ms
Importance: medium
The maximum time a message will remain ineligible for compaction in the log. Only applicable for logs that are being compacted.

max.message.bytes

Type: int
Default: 1048588
Valid Values: [0,...]
Server Default Property: message.max.bytes
Importance: medium
The largest record batch size allowed by Kafka (after compression if compression is enabled). If this is increased and there are consumers older than 0.10.2, the consumers' fetch size must also be increased so that they can fetch record batches this large. In the latest message format version, records are always grouped into batches for efficiency. In previous message format versions, uncompressed records are not grouped into batches and this limit only applies to a single record in that case.

message.format.version

Type: string
Default: 2.6-IV0
Valid Values: [0.8.0, 0.8.1, 0.8.2, 0.9.0, 0.10.0-IV0, 0.10.0-IV1, 0.10.1-IV0, 0.10.1-IV1, 0.10.1-IV2, 0.10.2-IV0, 0.11.0-IV0, 0.11.0-IV1, 0.11.0-IV2, 1.0-IV0, 1.1-IV0, 2.0-IV0, 2.0-IV1, 2.1-IV0, 2.1-IV1, 2.1-IV2, 2.2-IV0, 2.2-IV1, 2.3-IV0, 2.3-IV1, 2.4-IV0, 2.4-IV1, 2.5-IV0, 2.6-IV0]
Server Default Property: log.message.format.version
Importance: medium
Specify the message format version the broker will use to append messages to the logs. The value should be a valid ApiVersion. Some examples are: 0.8.2, 0.9.0.0, 0.10.0, check ApiVersion for more details. By setting a particular message format version, the user is certifying that all the existing messages on disk are smaller or equal than the specified version. Setting this value incorrectly will cause consumers with older versions to break as they will receive messages with a format that they don’t understand.

message.timestamp.difference.max.ms

Type: long
Default: 9223372036854775807
Valid Values: [0,...]
Server Default Property: log.message.timestamp.difference.max.ms
Importance: medium
The maximum difference allowed between the timestamp when a broker receives a message and the timestamp specified in the message. If message.timestamp.type=CreateTime, a message will be rejected if the difference in timestamp exceeds this threshold. This configuration is ignored if message.timestamp.type=LogAppendTime.

message.timestamp.type

Type: string
Default: CreateTime
Valid Values: [CreateTime, LogAppendTime]
Server Default Property: log.message.timestamp.type
Importance: medium
Define whether the timestamp in the message is message create time or log append time. The value should be either **CreateTime** or **LogAppendTime**.

min.cleanable.dirty.ratio

Type: double
Default: 0.5
Valid Values: [0,...,1]

Server Default Property: log.cleaner.min.cleanable.ratio
Importance: medium
This configuration controls how frequently the log compactor will attempt to clean the log (assuming log compaction is enabled). By default we will avoid cleaning a log where more than 50% of the log has been compacted. This ratio bounds the maximum space wasted in the log by duplicates (at 50% at most 50% of the log could be duplicates). A higher ratio will mean fewer, more efficient cleanings but will mean more wasted space in the log. If the max.compaction.lag.ms or the min.compaction.lag.ms configurations are also specified, then the log compactor considers the log to be eligible for compaction as soon as either: (i) the dirty ratio threshold has been met and the log has had dirty (uncompacted) records for at least the min.compaction.lag.ms duration, or (ii) if the log has had dirty (uncompacted) records for at most the max.compaction.lag.ms period.

min.compaction.lag.ms

Type: long
Default: 0
Valid Values: [0,...]
Server Default Property: log.cleaner.min.compaction.lag.ms
Importance: medium
The minimum time a message will remain uncompacted in the log. Only applicable for logs that are being compacted.

min.insync.replicas

Type: int
Default: 1
Valid Values: [1,...]
Server Default Property: min.insync.replicas
Importance: medium
When a producer sets acks to "all" (or "-1"), this configuration specifies the minimum number of replicas that must acknowledge a write for the write to be considered successful. If this minimum cannot be met, then the producer will raise an exception (either NotEnoughReplicas or NotEnoughReplicasAfterAppend). When used together, **min.insync.replicas** and **acks** allow you to enforce greater durability guarantees. A typical scenario would be to create a topic with a replication factor of 3, set **min.insync.replicas** to 2, and produce with **acks** of "all". This will ensure that the producer raises an exception if a majority of replicas do not receive a write.

preallocate

Type: boolean
Default: false
Server Default Property: log.preallocate
Importance: medium
True if we should preallocate the file on disk when creating a new log segment.

retention.bytes

Type: long
Default: -1
Server Default Property: log.retention.bytes
Importance: medium
This configuration controls the maximum size a partition (which consists of log segments) can grow to before we will discard old log segments to free up space if we are using the "delete" retention policy. By default there is no size limit only a time limit. Since this limit is enforced at the partition level, multiply it by the number of partitions to compute the topic retention in bytes.

retention.ms

Type: long
Default: 604800000 (7 days)
Valid Values: [-1,...]
Server Default Property: log.retention.ms
Importance: medium
This configuration controls the maximum time we will retain a log before we will discard old log segments to free up space if we are using the "delete" retention policy. This represents an SLA on how soon consumers must read their data. If set to -1, no time limit is applied.

segment.bytes

Type: int
Default: 1073741824 (1 gibibyte)
Valid Values: [14,...]
Server Default Property: log.segment.bytes
Importance: medium
This configuration controls the segment file size for the log. Retention and cleaning is always done a file at a time so a larger segment size means fewer files but less granular control over retention.

segment.index.bytes

Type: int
Default: 10485760 (10 mebibytes)
Valid Values: [0,...]
Server Default Property: log.index.size.max.bytes
Importance: medium
This configuration controls the size of the index that maps offsets to file positions. We preallocate this index file and shrink it only after log rolls. You generally should not need to change this setting.

segment.jitter.ms

Type: long
Default: 0
Valid Values: [0,...]
Server Default Property: log.roll.jitter.ms
Importance: medium
The maximum random jitter subtracted from the scheduled segment roll time to avoid thundering herds of segment rolling.

segment.ms

Type: long
Default: 604800000 (7 days)
Valid Values: [1,...]
Server Default Property: log.roll.ms
Importance: medium
This configuration controls the period of time after which Kafka will force the log to roll even if the segment file isn't full to ensure that retention can delete or compact old data.

unclean.leader.election.enable

Type: boolean
Default: false
Server Default Property: unclean.leader.election.enable
Importance: medium
Indicates whether to enable replicas not in the ISR set to be elected as leader as a last resort, even though doing so may result in data loss.

message.downconversion.enable

Type: boolean
Default: true
Server Default Property: log.message.downconversion.enable
Importance: low
This configuration controls whether down-conversion of message formats is enabled to satisfy consume requests. When set to **false**, broker will not perform down-conversion for consumers expecting an older message format. The broker responds with **UNSUPPORTED_VERSION** error for consume requests from such older clients. This configurationdoes not apply to any message format conversion that might be required for replication to followers.

APPENDIX C. CONSUMER CONFIGURATION PARAMETERS

key.deserializer

Type: class
Importance: high
Deserializer class for key that implements the **org.apache.kafka.common.serialization.Deserializer** interface.

value.deserializer

Type: class
Importance: high
Deserializer class for value that implements the **org.apache.kafka.common.serialization.Deserializer** interface.

bootstrap.servers

Type: list
Default: ""
Valid Values: non-null string
Importance: high
A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form **host1:port1,host2:port2,...**. Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

fetch.min.bytes

Type: int
Default: 1
Valid Values: [0,...]
Importance: high
The minimum amount of data the server should return for a fetch request. If insufficient data is available the request will wait for that much data to accumulate before answering the request. The default setting of 1 byte means that fetch requests are answered as soon as a single byte of data is available or the fetch request times out waiting for data to arrive. Setting this to something greater than 1 will cause the server to wait for larger amounts of data to accumulate which can improve server throughput a bit at the cost of some additional latency.

group.id

Type: string
Default: null
Importance: high
A unique string that identifies the consumer group this consumer belongs to. This property is required if the consumer uses either the group management functionality by using **subscribe(topic)** or the Kafka-based offset management strategy.

heartbeat.interval.ms

Type: int
Default: 3000 (3 seconds)
Importance: high
The expected time between heartbeats to the consumer coordinator when using Kafka's group management facilities. Heartbeats are used to ensure that the consumer's session stays active and to

facilitate rebalancing when new consumers join or leave the group. The value must be set lower than **session.timeout.ms**, but typically should be set no higher than 1/3 of that value. It can be adjusted even lower to control the expected time for normal rebalances.

max.partition.fetch.bytes

Type: int
Default: 1048576 (1 mebibyte)
Valid Values: [0,...]
Importance: high
The maximum amount of data per-partition the server will return. Records are fetched in batches by the consumer. If the first record batch in the first non-empty partition of the fetch is larger than this limit, the batch will still be returned to ensure that the consumer can make progress. The maximum record batch size accepted by the broker is defined via **message.max.bytes** (broker config) or **max.message.bytes** (topic config). See fetch.max.bytes for limiting the consumer request size.

session.timeout.ms

Type: int
Default: 10000 (10 seconds)
Importance: high
The timeout used to detect client failures when using Kafka's group management facility. The client sends periodic heartbeats to indicate its liveness to the broker. If no heartbeats are received by the broker before the expiration of this session timeout, then the broker will remove this client from the group and initiate a rebalance. Note that the value must be in the allowable range as configured in the broker configuration by **group.min.session.timeout.ms** and **group.max.session.timeout.ms**.

ssl.key.password

Type: password
Default: null
Importance: high
The password of the private key in the key store file. This is optional for client.

ssl.keystore.location

Type: string
Default: null
Importance: high
The location of the key store file. This is optional for client and can be used for two-way authentication for client.

ssl.keystore.password

Type: password
Default: null
Importance: high
The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

ssl.truststore.location

Type: string
Default: null
Importance: high
The location of the trust store file.

ssl.truststore.password

Type: password
Default: null
Importance: high
The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

allow.auto.create.topics

Type: boolean
Default: true
Importance: medium
Allow automatic topic creation on the broker when subscribing to or assigning a topic. A topic being subscribed to will be automatically created only if the broker allows for it using **auto.create.topics.enable** broker configuration. This configuration must be set to **false** when using brokers older than 0.11.0.

auto.offset.reset

Type: string
Default: latest
Valid Values: [latest, earliest, none]
Importance: medium
What to do when there is no initial offset in Kafka or if the current offset does not exist any more on the server (e.g. because that data has been deleted):

- earliest: automatically reset the offset to the earliest offset
- latest: automatically reset the offset to the latest offset
- none: throw exception to the consumer if no previous offset is found for the consumer's group
- anything else: throw exception to the consumer.

client.dns.lookup

Type: string
Default: use_all_dns_ips
Valid Values: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only]
Importance: medium
Controls how the client uses DNS lookups. If set to **use_all_dns_ips**, connect to each returned IP address in sequence until a successful connection is established. After a disconnection, the next IP is used. Once all IPs have been used once, the client resolves the IP(s) from the hostname again (both the JVM and the OS cache DNS name lookups, however). If set to **resolve_canonical_bootstrap_servers_only**, resolve each bootstrap address into a list of canonical names. After the bootstrap phase, this behaves the same as **use_all_dns_ips**. If set to **default** (deprecated), attempt to connect to the first IP address returned by the lookup, even if the lookup returns multiple IP addresses.

connections.max.idle.ms

Type: long
Default: 540000 (9 minutes)
Importance: medium
Close idle connections after the number of milliseconds specified by this config.

default.api.timeout.ms

Type: int
Default: 60000 (1 minute)
Valid Values: [0,...]
Importance: medium
Specifies the timeout (in milliseconds) for client APIs. This configuration is used as the default timeout for all client operations that do not specify a **timeout** parameter.

enable.auto.commit

Type: boolean
Default: true
Importance: medium
If true the consumer's offset will be periodically committed in the background.

exclude.internal.topics

Type: boolean
Default: true
Importance: medium
Whether internal topics matching a subscribed pattern should be excluded from the subscription. It is always possible to explicitly subscribe to an internal topic.

fetch.max.bytes

Type: int
Default: 52428800 (50 mebibytes)
Valid Values: [0,...]
Importance: medium
The maximum amount of data the server should return for a fetch request. Records are fetched in batches by the consumer, and if the first record batch in the first non-empty partition of the fetch is larger than this value, the record batch will still be returned to ensure that the consumer can make progress. As such, this is not a absolute maximum. The maximum record batch size accepted by the broker is defined via **message.max.bytes** (broker config) or **max.message.bytes** (topic config). Note that the consumer performs multiple fetches in parallel.

group.instance.id

Type: string
Default: null
Importance: medium
A unique identifier of the consumer instance provided by the end user. Only non-empty strings are permitted. If set, the consumer is treated as a static member, which means that only one instance with this ID is allowed in the consumer group at any time. This can be used in combination with a larger session timeout to avoid group rebalances caused by transient unavailability (e.g. process restarts). If not set, the consumer will join the group as a dynamic member, which is the traditional behavior.

isolation.level

Type: string
Default: read_uncommitted
Valid Values: [read_committed, read_uncommitted]
Importance: medium
Controls how to read messages written transactionally. If set to **read_committed**, consumer.poll() will only return transactional messages which have been committed. If set to `read_uncommitted' (the default), consumer.poll() will return all messages, even transactional messages which have been aborted. Non-transactional messages will be returned unconditionally in either mode.

Messages will always be returned in offset order. Hence, in **read_committed** mode, consumer.poll() will only return messages up to the last stable offset (LSO), which is the one less than the offset of the first open transaction. In particular any messages appearing after messages belonging to ongoing transactions will be withheld until the relevant transaction has been completed. As a result, **read_committed** consumers will not be able to read up to the high watermark when there are in flight transactions.

> Further, when in `read_committed` the seekToEnd method will return the LSO.

max.poll.interval.ms

Type: int
Default: 300000 (5 minutes)
Valid Values: [1,...]
Importance: medium
The maximum delay between invocations of poll() when using consumer group management. This places an upper bound on the amount of time that the consumer can be idle before fetching more records. If poll() is not called before expiration of this timeout, then the consumer is considered failed and the group will rebalance in order to reassign the partitions to another member. For consumers using a non-null **group.instance.id** which reach this timeout, partitions will not be immediately reassigned. Instead, the consumer will stop sending heartbeats and partitions will be reassigned after expiration of **session.timeout.ms**. This mirrors the behavior of a static consumer which has shutdown.

max.poll.records

Type: int
Default: 500
Valid Values: [1,...]
Importance: medium
The maximum number of records returned in a single call to poll().

partition.assignment.strategy

Type: list
Default: class org.apache.kafka.clients.consumer.RangeAssignor
Valid Values: non-null string
Importance: medium
A list of class names or class types, ordered by preference, of supported partition assignment strategies that the client will use to distribute partition ownership amongst consumer instances when group management is used.

In addition to the default class specified below, you can use the `org.apache.kafka.clients.consumer.RoundRobinAssignor`class for round robin assignments of partitions to consumers.

Implementing the **org.apache.kafka.clients.consumer.ConsumerPartitionAssignor** interface allows you to plug in a custom assignmentstrategy.

receive.buffer.bytes

Type: int
Default: 65536 (64 kibibytes)
Valid Values: [-1,...]
Importance: medium
The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

request.timeout.ms

Type: int
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: medium
The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

sasl.client.callback.handler.class

Type: class
Default: null
Importance: medium
The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

sasl.jaas.config

Type: password
Default: null
Importance: medium
JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: 'loginModuleClass controlFlag (optionName=optionValue)*;'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;.

sasl.kerberos.service.name

Type: string
Default: null
Importance: medium
The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

sasl.login.callback.handler.class

Type: class
Default: null
Importance: medium
The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler.

sasl.login.class

Type: class
Default: null
Importance: medium
The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin.

sasl.mechanism

Type: string
Default: GSSAPI
Importance: medium
SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

security.protocol

Type: string
Default: PLAINTEXT
Importance: medium
Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

send.buffer.bytes

Type: int
Default: 131072 (128 kibibytes)
Valid Values: [-1,...]
Importance: medium
The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

ssl.enabled.protocols

Type: list
Default: TLSv1.2,TLSv1.3
Importance: medium
The list of protocols enabled for SSL connections. The default is 'TLSv1.2,TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. With the default value for Java 11, clients and servers will prefer TLSv1.3 if both support it and fallback to TLSv1.2 otherwise (assuming both support at least TLSv1.2). This default should be fine for most cases. Also see the config documentation for **ssl.protocol**.

ssl.keystore.type

Type: string
Default: JKS
Importance: medium
The file format of the key store file. This is optional for client.

ssl.protocol

Type: string
Default: TLSv1.3
Importance: medium
The SSL protocol used to generate the SSLContext. The default is 'TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. This value should be fine for most use cases. Allowed values in recent JVMs are 'TLSv1.2' and 'TLSv1.3'. 'TLS', 'TLSv1.1', 'SSL', 'SSLv2' and 'SSLv3' may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities. With the default value for this config and 'ssl.enabled.protocols', clients will downgrade to 'TLSv1.2' if the server does not support 'TLSv1.3'. If this config is set to 'TLSv1.2', clients will not use 'TLSv1.3' even if it is one of the values in ssl.enabled.protocols and the server only supports 'TLSv1.3'.

ssl.provider

Type: string
Default: null
Importance: medium

The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

ssl.truststore.type

Type: string
Default: JKS
Importance: medium
The file format of the trust store file.

auto.commit.interval.ms

Type: int
Default: 5000 (5 seconds)
Valid Values: [0,...]
Importance: low
The frequency in milliseconds that the consumer offsets are auto-committed to Kafka if **enable.auto.commit** is set to **true**.

check.crcs

Type: boolean
Default: true
Importance: low
Automatically check the CRC32 of the records consumed. This ensures no on-the-wire or on-disk corruption to the messages occurred. This check adds some overhead, so it may be disabled in cases seeking extreme performance.

client.id

Type: string
Default: ""
Importance: low
An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

client.rack

Type: string
Default: ""
Importance: low
A rack identifier for this client. This can be any string value which indicates where this client is physically located. It corresponds with the broker config 'broker.rack'.

fetch.max.wait.ms

Type: int
Default: 500
Valid Values: [0,...]
Importance: low
The maximum amount of time the server will block before answering the fetch request if there isn't sufficient data to immediately satisfy the requirement given by fetch.min.bytes.

interceptor.classes

Type: list
Default: ""

Valid Values: non-null string
Importance: low
A list of classes to use as interceptors. Implementing the **org.apache.kafka.clients.consumer.ConsumerInterceptor** interface allows you to intercept (and possibly mutate) records received by the consumer. By default, there are no interceptors.

metadata.max.age.ms

Type: long
Default: 300000 (5 minutes)
Valid Values: [0,...]
Importance: low
The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

metric.reporters

Type: list
Default: ""
Valid Values: non-null string
Importance: low
A list of classes to use as metrics reporters. Implementing the **org.apache.kafka.common.metrics.MetricsReporter** interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

metrics.num.samples

Type: int
Default: 2
Valid Values: [1,...]
Importance: low
The number of samples maintained to compute metrics.

metrics.recording.level

Type: string
Default: INFO
Valid Values: [INFO, DEBUG]
Importance: low
The highest recording level for metrics.

metrics.sample.window.ms

Type: long
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: low
The window of time a metrics sample is computed over.

reconnect.backoff.max.ms

Type: long
Default: 1000 (1 second)
Valid Values: [0,...]
Importance: low
The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20%

random jitter is added to avoid connection storms.

reconnect.backoff.ms

Type: long
Default: 50
Valid Values: [0,...]
Importance: low
The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

retry.backoff.ms

Type: long
Default: 100
Valid Values: [0,...]
Importance: low
The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

sasl.kerberos.kinit.cmd

Type: string
Default: /usr/bin/kinit
Importance: low
Kerberos kinit command path.

sasl.kerberos.min.time.before.relogin

Type: long
Default: 60000
Importance: low
Login thread sleep time between refresh attempts.

sasl.kerberos.ticket.renew.jitter

Type: double
Default: 0.05
Importance: low
Percentage of random jitter added to the renewal time.

sasl.kerberos.ticket.renew.window.factor

Type: double
Default: 0.8
Importance: low
Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

sasl.login.refresh.buffer.seconds

Type: short
Default: 300
Valid Values: [0,...,3600]
Importance: low
The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds

then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.min.period.seconds

Type: short
Default: 60
Valid Values: [0,...,900]
Importance: low
The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.factor

Type: double
Default: 0.8
Valid Values: [0.5,...,1.0]
Importance: low
Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.jitter

Type: double
Default: 0.05
Valid Values: [0.0,...,0.25]
Importance: low
The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

security.providers

Type: string
Default: null
Importance: low
A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the **org.apache.kafka.common.security.auth.SecurityProviderCreator** interface.

ssl.cipher.suites

Type: list
Default: null
Importance: low
A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

ssl.endpoint.identification.algorithm

Type: string
Default: https
Importance: low
The endpoint identification algorithm to validate server hostname using server certificate.

ssl.engine.factory.class

Type: class
Default: null
Importance: low
The class of type org.apache.kafka.common.security.auth.SslEngineFactory to provide SSLEngine objects. Default value is org.apache.kafka.common.security.ssl.DefaultSslEngineFactory.

ssl.keymanager.algorithm

Type: string
Default: SunX509
Importance: low
The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

ssl.secure.random.implementation

Type: string
Default: null
Importance: low
The SecureRandom PRNG implementation to use for SSL cryptography operations.

ssl.trustmanager.algorithm

Type: string
Default: PKIX
Importance: low
The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

APPENDIX D. PRODUCER CONFIGURATION PARAMETERS

key.serializer

Type: class
Importance: high
Serializer class for key that implements the **org.apache.kafka.common.serialization.Serializer** interface.

value.serializer

Type: class
Importance: high
Serializer class for value that implements the **org.apache.kafka.common.serialization.Serializer** interface.

acks

Type: string
Default: 1
Valid Values: [all, -1, 0, 1]
Importance: high
The number of acknowledgments the producer requires the leader to have received before considering a request complete. This controls the durability of records that are sent. The following settings are allowed:

- **acks=0** If set to zero then the producer will not wait for any acknowledgment from the server at all. The record will be immediately added to the socket buffer and considered sent. No guarantee can be made that the server has received the record in this case, and the **retries** configuration will not take effect (as the client won't generally know of any failures). The offset given back for each record will always be set to **-1**.

- **acks=1** This will mean the leader will write the record to its local log but will respond without awaiting full acknowledgement from all followers. In this case should the leader fail immediately after acknowledging the record but before the followers have replicated it then the record will be lost.

- **acks=all** This means the leader will wait for the full set of in-sync replicas to acknowledge the record. This guarantees that the record will not be lost as long as at least one in-sync replica remains alive. This is the strongest available guarantee. This is equivalent to the acks=-1 setting.

bootstrap.servers

Type: list
Default: ""
Valid Values: non-null string
Importance: high
A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form **host1:port1,host2:port2,...**. Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

buffer.memory

Type: long

Default: 33554432
Valid Values: [0,...]
Importance: high
The total bytes of memory the producer can use to buffer records waiting to be sent to the server. If records are sent faster than they can be delivered to the server the producer will block for **max.block.ms** after which it will throw an exception.

This setting should correspond roughly to the total memory the producer will use, but is not a hard bound since not all memory the producer uses is used for buffering. Some additional memory will be used for compression (if compression is enabled) as well as for maintaining in-flight requests.

compression.type

Type: string
Default: none
Importance: high
The compression type for all data generated by the producer. The default is none (i.e. no compression). Valid values are **none**, **gzip**, **snappy**, **lz4**, or **zstd**. Compression is of full batches of data, so the efficacy of batching will also impact the compression ratio (more batching means better compression).

retries

Type: int
Default: 2147483647
Valid Values: [0,...,2147483647]
Importance: high
Setting a value greater than zero will cause the client to resend any record whose send fails with a potentially transient error. Note that this retry is no different than if the client resent the record upon receiving the error. Allowing retries without setting **max.in.flight.requests.per.connection** to 1 will potentially change the ordering of records because if two batches are sent to a single partition, and the first fails and is retried but the second succeeds, then the records in the second batch may appear first. Note additionally that produce requests will be failed before the number of retries has been exhausted if the timeout configured by **delivery.timeout.ms** expires first before successful acknowledgement. Users should generally prefer to leave this config unset and instead use **delivery.timeout.ms** to control retry behavior.

ssl.key.password

Type: password
Default: null
Importance: high
The password of the private key in the key store file. This is optional for client.

ssl.keystore.location

Type: string
Default: null
Importance: high
The location of the key store file. This is optional for client and can be used for two-way authentication for client.

ssl.keystore.password

Type: password
Default: null
Importance: high

The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

ssl.truststore.location

Type: string
Default: null
Importance: high
The location of the trust store file.

ssl.truststore.password

Type: password
Default: null
Importance: high
The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

batch.size

Type: int
Default: 16384
Valid Values: [0,...]
Importance: medium
The producer will attempt to batch records together into fewer requests whenever multiple records are being sent to the same partition. This helps performance on both the client and the server. This configuration controls the default batch size in bytes.

No attempt will be made to batch records larger than this size.

Requests sent to brokers will contain multiple batches, one for each partition with data available to be sent.

A small batch size will make batching less common and may reduce throughput (a batch size of zero will disable batching entirely). A very large batch size may use memory a bit more wastefully as we will always allocate a buffer of the specified batch size in anticipation of additional records.

client.dns.lookup

Type: string
Default: use_all_dns_ips
Valid Values: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only]
Importance: medium
Controls how the client uses DNS lookups. If set to **use_all_dns_ips**, connect to each returned IP address in sequence until a successful connection is established. After a disconnection, the next IP is used. Once all IPs have been used once, the client resolves the IP(s) from the hostname again (both the JVM and the OS cache DNS name lookups, however). If set to **resolve_canonical_bootstrap_servers_only**, resolve each bootstrap address into a list of canonical names. After the bootstrap phase, this behaves the same as **use_all_dns_ips**. If set to **default** (deprecated), attempt to connect to the first IP address returned by the lookup, even if the lookup returns multiple IP addresses.

client.id

Type: string
Default: ""
Importance: medium

An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

connections.max.idle.ms

Type: long
Default: 540000 (9 minutes)
Importance: medium
Close idle connections after the number of milliseconds specified by this config.

delivery.timeout.ms

Type: int
Default: 120000 (2 minutes)
Valid Values: [0,...]
Importance: medium
An upper bound on the time to report success or failure after a call to **send()** returns. This limits the total time that a record will be delayed prior to sending, the time to await acknowledgement from the broker (if expected), and the time allowed for retriable send failures. The producer may report failure to send a record earlier than this config if either an unrecoverable error is encountered, the retries have been exhausted, or the record is added to a batch which reached an earlier delivery expiration deadline. The value of this config should be greater than or equal to the sum of **request.timeout.ms** and **linger.ms**.

linger.ms

Type: long
Default: 0
Valid Values: [0,...]
Importance: medium
The producer groups together any records that arrive in between request transmissions into a single batched request. Normally this occurs only under load when records arrive faster than they can be sent out. However in some circumstances the client may want to reduce the number of requests even under moderate load. This setting accomplishes this by adding a small amount of artificial delay—that is, rather than immediately sending out a record the producer will wait for up to the given delay to allow other records to be sent so that the sends can be batched together. This can be thought of as analogous to Nagle's algorithm in TCP. This setting gives the upper bound on the delay for batching: once we get **batch.size** worth of records for a partition it will be sent immediately regardless of this setting, however if we have fewer than this many bytes accumulated for this partition we will 'linger' for the specified time waiting for more records to show up. This setting defaults to 0 (i.e. no delay). Setting **linger.ms=5**, for example, would have the effect of reducing the number of requests sent but would add up to 5ms of latency to records sent in the absence of load.

max.block.ms

Type: long
Default: 60000 (1 minute)
Valid Values: [0,...]
Importance: medium
The configuration controls how long **KafkaProducer.send()** and **KafkaProducer.partitionsFor()** will block.These methods can be blocked either because the buffer is full or metadata unavailable.Blocking in the user-supplied serializers or partitioner will not be counted against this timeout.

max.request.size

Type: int

Default: 1048576
Valid Values: [0,...]
Importance: medium
The maximum size of a request in bytes. This setting will limit the number of record batches the producer will send in a single request to avoid sending huge requests. This is also effectively a cap on the maximum uncompressed record batch size. Note that the server has its own cap on the record batch size (after compression if compression is enabled) which may be different from this.

partitioner.class

Type: class
Default: org.apache.kafka.clients.producer.internals.DefaultPartitioner
Importance: medium
Partitioner class that implements the **org.apache.kafka.clients.producer.Partitioner** interface.

receive.buffer.bytes

Type: int
Default: 32768 (32 kibibytes)
Valid Values: [-1,...]
Importance: medium
The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

request.timeout.ms

Type: int
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: medium
The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted. This should be larger than **replica.lag.time.max.ms** (a broker configuration) to reduce the possibility of message duplication due to unnecessary producer retries.

sasl.client.callback.handler.class

Type: class
Default: null
Importance: medium
The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

sasl.jaas.config

Type: password
Default: null
Importance: medium
JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: 'loginModuleClass controlFlag (optionName=optionValue)*;'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;.

sasl.kerberos.service.name

Type: string
Default: null
Importance: medium
The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

sasl.login.callback.handler.class

Type: class
Default: null
Importance: medium
The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler.

sasl.login.class

Type: class
Default: null
Importance: medium
The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin.

sasl.mechanism

Type: string
Default: GSSAPI
Importance: medium
SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

security.protocol

Type: string
Default: PLAINTEXT
Importance: medium
Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

send.buffer.bytes

Type: int
Default: 131072 (128 kibibytes)
Valid Values: [-1,...]
Importance: medium
The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

ssl.enabled.protocols

Type: list
Default: TLSv1.2,TLSv1.3
Importance: medium
The list of protocols enabled for SSL connections. The default is 'TLSv1.2,TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. With the default value for Java 11, clients and servers will prefer

TLSv1.3 if both support it and fallback to TLSv1.2 otherwise (assuming both support at least TLSv1.2). This default should be fine for most cases. Also see the config documentation for **ssl.protocol**.

ssl.keystore.type

Type: string
Default: JKS
Importance: medium
The file format of the key store file. This is optional for client.

ssl.protocol

Type: string
Default: TLSv1.3
Importance: medium
The SSL protocol used to generate the SSLContext. The default is 'TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. This value should be fine for most use cases. Allowed values in recent JVMs are 'TLSv1.2' and 'TLSv1.3'. 'TLS', 'TLSv1.1', 'SSL', 'SSLv2' and 'SSLv3' may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities. With the default value for this config and 'ssl.enabled.protocols', clients will downgrade to 'TLSv1.2' if the server does not support 'TLSv1.3'. If this config is set to 'TLSv1.2', clients will not use 'TLSv1.3' even if it is one of the values in ssl.enabled.protocols and the server only supports 'TLSv1.3'.

ssl.provider

Type: string
Default: null
Importance: medium
The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

ssl.truststore.type

Type: string
Default: JKS
Importance: medium
The file format of the trust store file.

enable.idempotence

Type: boolean
Default: false
Importance: low
When set to 'true', the producer will ensure that exactly one copy of each message is written in the stream. If 'false', producer retries due to broker failures, etc., may write duplicates of the retried message in the stream. Note that enabling idempotence requires **max.in.flight.requests.per.connection** to be less than or equal to 5, **retries** to be greater than 0 and **acks** must be 'all'. If these values are not explicitly set by the user, suitable values will be chosen. If incompatible values are set, a **ConfigException** will be thrown.

interceptor.classes

Type: list
Default: ""
Valid Values: non-null string
Importance: low
A list of classes to use as interceptors. Implementing the **org.apache.kafka.clients.producer.ProducerInterceptor** interface allows you to intercept (and

possibly mutate) the records received by the producer before they are published to the Kafka cluster. By default, there are no interceptors.

max.in.flight.requests.per.connection

Type: int
Default: 5
Valid Values: [1,...]
Importance: low
The maximum number of unacknowledged requests the client will send on a single connection before blocking. Note that if this setting is set to be greater than 1 and there are failed sends, there is a risk of message re-ordering due to retries (i.e., if retries are enabled).

metadata.max.age.ms

Type: long
Default: 300000 (5 minutes)
Valid Values: [0,...]
Importance: low
The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

metadata.max.idle.ms

Type: long
Default: 300000 (5 minutes)
Valid Values: [5000,...]
Importance: low
Controls how long the producer will cache metadata for a topic that's idle. If the elapsed time since a topic was last produced to exceeds the metadata idle duration, then the topic's metadata is forgotten and the next access to it will force a metadata fetch request.

metric.reporters

Type: list
Default: ""
Valid Values: non-null string
Importance: low
A list of classes to use as metrics reporters. Implementing the **org.apache.kafka.common.metrics.MetricsReporter** interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

metrics.num.samples

Type: int
Default: 2
Valid Values: [1,...]
Importance: low
The number of samples maintained to compute metrics.

metrics.recording.level

Type: string
Default: INFO
Valid Values: [INFO, DEBUG]
Importance: low
The highest recording level for metrics.

metrics.sample.window.ms

Type: long
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: low
The window of time a metrics sample is computed over.

reconnect.backoff.max.ms

Type: long
Default: 1000 (1 second)
Valid Values: [0,...]
Importance: low
The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

reconnect.backoff.ms

Type: long
Default: 50
Valid Values: [0,...]
Importance: low
The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

retry.backoff.ms

Type: long
Default: 100
Valid Values: [0,...]
Importance: low
The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

sasl.kerberos.kinit.cmd

Type: string
Default: /usr/bin/kinit
Importance: low
Kerberos kinit command path.

sasl.kerberos.min.time.before.relogin

Type: long
Default: 60000
Importance: low
Login thread sleep time between refresh attempts.

sasl.kerberos.ticket.renew.jitter

Type: double
Default: 0.05
Importance: low
Percentage of random jitter added to the renewal time.

sasl.kerberos.ticket.renew.window.factor

Type: double
Default: 0.8
Importance: low
Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

sasl.login.refresh.buffer.seconds

Type: short
Default: 300
Valid Values: [0,...,3600]
Importance: low
The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.min.period.seconds

Type: short
Default: 60
Valid Values: [0,...,900]
Importance: low
The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.factor

Type: double
Default: 0.8
Valid Values: [0.5,...,1.0]
Importance: low
Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.jitter

Type: double
Default: 0.05
Valid Values: [0.0,...,0.25]
Importance: low
The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

security.providers

Type: string
Default: null
Importance: low

A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the **org.apache.kafka.common.security.auth.SecurityProviderCreator** interface.

ssl.cipher.suites

Type: list
Default: null
Importance: low
A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

ssl.endpoint.identification.algorithm

Type: string
Default: https
Importance: low
The endpoint identification algorithm to validate server hostname using server certificate.

ssl.engine.factory.class

Type: class
Default: null
Importance: low
The class of type org.apache.kafka.common.security.auth.SslEngineFactory to provide SSLEngine objects. Default value is org.apache.kafka.common.security.ssl.DefaultSslEngineFactory.

ssl.keymanager.algorithm

Type: string
Default: SunX509
Importance: low
The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

ssl.secure.random.implementation

Type: string
Default: null
Importance: low
The SecureRandom PRNG implementation to use for SSL cryptography operations.

ssl.trustmanager.algorithm

Type: string
Default: PKIX
Importance: low
The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

transaction.timeout.ms

Type: int
Default: 60000 (1 minute)
Importance: low
The maximum amount of time in ms that the transaction coordinator will wait for a transaction status update from the producer before proactively aborting the ongoing transaction.If this value is larger

than the transaction.max.timeout.ms setting in the broker, the request will fail with a **InvalidTransactionTimeout** error.

transactional.id

Type: string
Default: null
Valid Values: non-empty string
Importance: low
The TransactionalId to use for transactional delivery. This enables reliability semantics which span multiple producer sessions since it allows the client to guarantee that transactions using the same TransactionalId have been completed prior to starting any new transactions. If no TransactionalId is provided, then the producer is limited to idempotent delivery. If a TransactionalId is configured, **enable.idempotence** is implied. By default the TransactionId is not configured, which means transactions cannot be used. Note that, by default, transactions require a cluster of at least three brokers which is the recommended setting for production; for development you can change this, by adjusting broker setting **transaction.state.log.replication.factor**.

APPENDIX E. ADMIN CLIENT CONFIGURATION PARAMETERS

bootstrap.servers

Type: list
Importance: high
A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form **host1:port1,host2:port2,...**. Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

ssl.key.password

Type: password
Default: null
Importance: high
The password of the private key in the key store file. This is optional for client.

ssl.keystore.location

Type: string
Default: null
Importance: high
The location of the key store file. This is optional for client and can be used for two-way authentication for client.

ssl.keystore.password

Type: password
Default: null
Importance: high
The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

ssl.truststore.location

Type: string
Default: null
Importance: high
The location of the trust store file.

ssl.truststore.password

Type: password
Default: null
Importance: high
The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

client.dns.lookup

Type: string
Default: use_all_dns_ips
Valid Values: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only]
Importance: medium
Controls how the client uses DNS lookups. If set to **use_all_dns_ips**, connect to each returned IP

address in sequence until a successful connection is established. After a disconnection, the next IP is used. Once all IPs have been used once, the client resolves the IP(s) from the hostname again (both the JVM and the OS cache DNS name lookups, however). If set to **resolve_canonical_bootstrap_servers_only**, resolve each bootstrap address into a list of canonical names. After the bootstrap phase, this behaves the same as **use_all_dns_ips**. If set to **default** (deprecated), attempt to connect to the first IP address returned by the lookup, even if the lookup returns multiple IP addresses.

client.id

Type: string
Default: ""
Importance: medium
An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

connections.max.idle.ms

Type: long
Default: 300000 (5 minutes)
Importance: medium
Close idle connections after the number of milliseconds specified by this config.

default.api.timeout.ms

Type: int
Default: 60000 (1 minute)
Valid Values: [0,...]
Importance: medium
Specifies the timeout (in milliseconds) for client APIs. This configuration is used as the default timeout for all client operations that do not specify a **timeout** parameter.

receive.buffer.bytes

Type: int
Default: 65536 (64 kibibytes)
Valid Values: [-1,...]
Importance: medium
The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

request.timeout.ms

Type: int
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: medium
The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

sasl.client.callback.handler.class

Type: class
Default: null
Importance: medium

The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

sasl.jaas.config

Type: password
Default: null
Importance: medium
JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: 'loginModuleClass controlFlag (optionName=optionValue)*;'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;.

sasl.kerberos.service.name

Type: string
Default: null
Importance: medium
The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

sasl.login.callback.handler.class

Type: class
Default: null
Importance: medium
The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler.

sasl.login.class

Type: class
Default: null
Importance: medium
The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin.

sasl.mechanism

Type: string
Default: GSSAPI
Importance: medium
SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

security.protocol

Type: string
Default: PLAINTEXT
Importance: medium
Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

send.buffer.bytes

Type: int
Default: 131072 (128 kibibytes)
Valid Values: [-1,...]
Importance: medium
The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

ssl.enabled.protocols

Type: list
Default: TLSv1.2,TLSv1.3
Importance: medium
The list of protocols enabled for SSL connections. The default is 'TLSv1.2,TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. With the default value for Java 11, clients and servers will prefer TLSv1.3 if both support it and fallback to TLSv1.2 otherwise (assuming both support at least TLSv1.2). This default should be fine for most cases. Also see the config documentation for **ssl.protocol**.

ssl.keystore.type

Type: string
Default: JKS
Importance: medium
The file format of the key store file. This is optional for client.

ssl.protocol

Type: string
Default: TLSv1.3
Importance: medium
The SSL protocol used to generate the SSLContext. The default is 'TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. This value should be fine for most use cases. Allowed values in recent JVMs are 'TLSv1.2' and 'TLSv1.3'. 'TLS', 'TLSv1.1', 'SSL', 'SSLv2' and 'SSLv3' may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities. With the default value for this config and 'ssl.enabled.protocols', clients will downgrade to 'TLSv1.2' if the server does not support 'TLSv1.3'. If this config is set to 'TLSv1.2', clients will not use 'TLSv1.3' even if it is one of the values in ssl.enabled.protocols and the server only supports 'TLSv1.3'.

ssl.provider

Type: string
Default: null
Importance: medium
The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

ssl.truststore.type

Type: string
Default: JKS
Importance: medium
The file format of the trust store file.

metadata.max.age.ms

Type: long
Default: 300000 (5 minutes)

Valid Values: [0,...]
Importance: low
The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

metric.reporters

Type: list
Default: ""
Importance: low
A list of classes to use as metrics reporters. Implementing the **org.apache.kafka.common.metrics.MetricsReporter** interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

metrics.num.samples

Type: int
Default: 2
Valid Values: [1,...]
Importance: low
The number of samples maintained to compute metrics.

metrics.recording.level

Type: string
Default: INFO
Valid Values: [INFO, DEBUG]
Importance: low
The highest recording level for metrics.

metrics.sample.window.ms

Type: long
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: low
The window of time a metrics sample is computed over.

reconnect.backoff.max.ms

Type: long
Default: 1000 (1 second)
Valid Values: [0,...]
Importance: low
The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

reconnect.backoff.ms

Type: long
Default: 50
Valid Values: [0,...]
Importance: low
The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

retries

Type: int
Default: 2147483647
Valid Values: [0,...,2147483647]
Importance: low
Setting a value greater than zero will cause the client to resend any request that fails with a potentially transient error.

retry.backoff.ms

Type: long
Default: 100
Valid Values: [0,...]
Importance: low
The amount of time to wait before attempting to retry a failed request. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

sasl.kerberos.kinit.cmd

Type: string
Default: /usr/bin/kinit
Importance: low
Kerberos kinit command path.

sasl.kerberos.min.time.before.relogin

Type: long
Default: 60000
Importance: low
Login thread sleep time between refresh attempts.

sasl.kerberos.ticket.renew.jitter

Type: double
Default: 0.05
Importance: low
Percentage of random jitter added to the renewal time.

sasl.kerberos.ticket.renew.window.factor

Type: double
Default: 0.8
Importance: low
Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

sasl.login.refresh.buffer.seconds

Type: short
Default: 300
Valid Values: [0,...,3600]
Importance: low
The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are

between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.min.period.seconds

Type: short
Default: 60
Valid Values: [0,...,900]
Importance: low
The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.factor

Type: double
Default: 0.8
Valid Values: [0.5,...,1.0]
Importance: low
Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.jitter

Type: double
Default: 0.05
Valid Values: [0.0,...,0.25]
Importance: low
The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

security.providers

Type: string
Default: null
Importance: low
A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the **org.apache.kafka.common.security.auth.SecurityProviderCreator** interface.

ssl.cipher.suites

Type: list
Default: null
Importance: low
A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

ssl.endpoint.identification.algorithm

Type: string
Default: https
Importance: low
The endpoint identification algorithm to validate server hostname using server certificate.

ssl.engine.factory.class

Type: class
Default: null
Importance: low
The class of type org.apache.kafka.common.security.auth.SslEngineFactory to provide SSLEngine objects. Default value is org.apache.kafka.common.security.ssl.DefaultSslEngineFactory.

ssl.keymanager.algorithm

Type: string
Default: SunX509
Importance: low
The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

ssl.secure.random.implementation

Type: string
Default: null
Importance: low
The SecureRandom PRNG implementation to use for SSL cryptography operations.

ssl.trustmanager.algorithm

Type: string
Default: PKIX
Importance: low
The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

APPENDIX F. KAFKA CONNECT CONFIGURATION PARAMETERS

config.storage.topic

Type: string
Importance: high
The name of the Kafka topic where connector configurations are stored.

group.id

Type: string
Importance: high
A unique string that identifies the Connect cluster group this worker belongs to.

key.converter

Type: class
Importance: high
Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the keys in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

offset.storage.topic

Type: string
Importance: high
The name of the Kafka topic where connector offsets are stored.

status.storage.topic

Type: string
Importance: high
The name of the Kafka topic where connector and task status are stored.

value.converter

Type: class
Importance: high
Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

bootstrap.servers

Type: list
Default: localhost:9092
Importance: high
A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form **host1:port1,host2:port2,...**. Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

heartbeat.interval.ms

Type: int
Default: 3000 (3 seconds)
Importance: high
The expected time between heartbeats to the group coordinator when using Kafka's group management facilities. Heartbeats are used to ensure that the worker's session stays active and to facilitate rebalancing when new members join or leave the group. The value must be set lower than **session.timeout.ms**, but typically should be set no higher than 1/3 of that value. It can be adjusted even lower to control the expected time for normal rebalances.

rebalance.timeout.ms

Type: int
Default: 60000 (1 minute)
Importance: high
The maximum allowed time for each worker to join the group once a rebalance has begun. This is basically a limit on the amount of time needed for all tasks to flush any pending data and commit offsets. If the timeout is exceeded, then the worker will be removed from the group, which will cause offset commit failures.

session.timeout.ms

Type: int
Default: 10000 (10 seconds)
Importance: high
The timeout used to detect worker failures. The worker sends periodic heartbeats to indicate its liveness to the broker. If no heartbeats are received by the broker before the expiration of this session timeout, then the broker will remove the worker from the group and initiate a rebalance. Note that the value must be in the allowable range as configured in the broker configuration by **group.min.session.timeout.ms** and **group.max.session.timeout.ms**.

ssl.key.password

Type: password
Default: null
Importance: high
The password of the private key in the key store file. This is optional for client.

ssl.keystore.location

Type: string
Default: null
Importance: high
The location of the key store file. This is optional for client and can be used for two-way authentication for client.

ssl.keystore.password

Type: password
Default: null
Importance: high
The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

ssl.truststore.location

Type: string
Default: null
Importance: high
The location of the trust store file.

ssl.truststore.password

Type: password
Default: null
Importance: high
The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

client.dns.lookup

Type: string
Default: use_all_dns_ips
Valid Values: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only]
Importance: medium
Controls how the client uses DNS lookups. If set to **use_all_dns_ips**, connect to each returned IP address in sequence until a successful connection is established. After a disconnection, the next IP is used. Once all IPs have been used once, the client resolves the IP(s) from the hostname again (both the JVM and the OS cache DNS name lookups, however). If set to **resolve_canonical_bootstrap_servers_only**, resolve each bootstrap address into a list of canonical names. After the bootstrap phase, this behaves the same as **use_all_dns_ips**. If set to **default** (deprecated), attempt to connect to the first IP address returned by the lookup, even if the lookup returns multiple IP addresses.

connections.max.idle.ms

Type: long
Default: 540000 (9 minutes)
Importance: medium
Close idle connections after the number of milliseconds specified by this config.

connector.client.config.override.policy

Type: string
Default: None
Importance: medium
Class name or alias of implementation of **ConnectorClientConfigOverridePolicy**. Defines what client configurations can be overriden by the connector. The default implementation is **None**. The other possible policies in the framework include **All** and **Principal**.

receive.buffer.bytes

Type: int
Default: 32768 (32 kibibytes)
Valid Values: [0,...]
Importance: medium
The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

request.timeout.ms

Type: int
Default: 40000 (40 seconds)
Valid Values: [0,...]

Importance: medium
The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

sasl.client.callback.handler.class

Type: class
Default: null
Importance: medium
The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

sasl.jaas.config

Type: password
Default: null
Importance: medium
JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: 'loginModuleClass controlFlag (optionName=optionValue)*;'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;.

sasl.kerberos.service.name

Type: string
Default: null
Importance: medium
The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

sasl.login.callback.handler.class

Type: class
Default: null
Importance: medium
The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler.

sasl.login.class

Type: class
Default: null
Importance: medium
The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin.

sasl.mechanism

Type: string
Default: GSSAPI
Importance: medium

SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

security.protocol

Type: string
Default: PLAINTEXT
Importance: medium
Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

send.buffer.bytes

Type: int
Default: 131072 (128 kibibytes)
Valid Values: [0,...]
Importance: medium
The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

ssl.enabled.protocols

Type: list
Default: TLSv1.2,TLSv1.3
Importance: medium
The list of protocols enabled for SSL connections. The default is 'TLSv1.2,TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. With the default value for Java 11, clients and servers will prefer TLSv1.3 if both support it and fallback to TLSv1.2 otherwise (assuming both support at least TLSv1.2). This default should be fine for most cases. Also see the config documentation for **ssl.protocol**.

ssl.keystore.type

Type: string
Default: JKS
Importance: medium
The file format of the key store file. This is optional for client.

ssl.protocol

Type: string
Default: TLSv1.3
Importance: medium
The SSL protocol used to generate the SSLContext. The default is 'TLSv1.3' when running with Java 11 or newer, 'TLSv1.2' otherwise. This value should be fine for most use cases. Allowed values in recent JVMs are 'TLSv1.2' and 'TLSv1.3'. 'TLS', 'TLSv1.1', 'SSL', 'SSLv2' and 'SSLv3' may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities. With the default value for this config and 'ssl.enabled.protocols', clients will downgrade to 'TLSv1.2' if the server does not support 'TLSv1.3'. If this config is set to 'TLSv1.2', clients will not use 'TLSv1.3' even if it is one of the values in ssl.enabled.protocols and the server only supports 'TLSv1.3'.

ssl.provider

Type: string
Default: null
Importance: medium
The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

ssl.truststore.type

Type: string
Default: JKS
Importance: medium
The file format of the trust store file.

worker.sync.timeout.ms

Type: int
Default: 3000 (3 seconds)
Importance: medium
When the worker is out of sync with other workers and needs to resynchronize configurations, wait up to this amount of time before giving up, leaving the group, and waiting a backoff period before rejoining.

worker.unsync.backoff.ms

Type: int
Default: 300000 (5 minutes)
Importance: medium
When the worker is out of sync with other workers and fails to catch up within worker.sync.timeout.ms, leave the Connect cluster for this long before rejoining.

access.control.allow.methods

Type: string
Default: ""
Importance: low
Sets the methods supported for cross origin requests by setting the Access-Control-Allow-Methods header. The default value of the Access-Control-Allow-Methods header allows cross origin requests for GET, POST and HEAD.

access.control.allow.origin

Type: string
Default: ""
Importance: low
Value to set the Access-Control-Allow-Origin header to for REST API requests.To enable cross origin access, set this to the domain of the application that should be permitted to access the API, or '*' to allow access from any domain. The default value only allows access from the domain of the REST API.

admin.listeners

Type: list
Default: null
Valid Values: org.apache.kafka.connect.runtime.WorkerConfig$AdminListenersValidator@6fffcba5
Importance: low
List of comma-separated URIs the Admin REST API will listen on. The supported protocols are HTTP and HTTPS. An empty or blank string will disable this feature. The default behavior is to use the regular listener (specified by the 'listeners' property).

client.id

Type: string
Default: ""
Importance: low

An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

config.providers

Type: list
Default: ""
Importance: low
Comma-separated names of **ConfigProvider** classes, loaded and used in the order specified. Implementing the interface **ConfigProvider** allows you to replace variable references in connector configurations, such as for externalized secrets.

config.storage.replication.factor

Type: short
Default: 3
Valid Values: Positive number not larger than the number of brokers in the Kafka cluster, or -1 to use the broker's default
Importance: low
Replication factor used when creating the configuration storage topic.

connect.protocol

Type: string
Default: sessioned
Valid Values: [eager, compatible, sessioned]
Importance: low
Compatibility mode for Kafka Connect Protocol.

header.converter

Type: class
Default: org.apache.kafka.connect.storage.SimpleHeaderConverter
Importance: low
HeaderConverter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the header values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. By default, the SimpleHeaderConverter is used to serialize header values to strings and deserialize them by inferring the schemas.

inter.worker.key.generation.algorithm

Type: string
Default: HmacSHA256
Valid Values: Any KeyGenerator algorithm supported by the worker JVM
Importance: low
The algorithm to use for generating internal request keys.

inter.worker.key.size

Type: int
Default: null
Importance: low
The size of the key to use for signing internal requests, in bits. If null, the default key size for the key generation algorithm will be used.

inter.worker.key.ttl.ms

Type: int
Default: 3600000 (1 hour)
Valid Values: [0,...,2147483647]
Importance: low
The TTL of generated session keys used for internal request validation (in milliseconds).

inter.worker.signature.algorithm

Type: string
Default: HmacSHA256
Valid Values: Any MAC algorithm supported by the worker JVM
Importance: low
The algorithm used to sign internal requests.

inter.worker.verification.algorithms

Type: list
Default: HmacSHA256
Valid Values: A list of one or more MAC algorithms, each supported by the worker JVM
Importance: low
A list of permitted algorithms for verifying internal requests.

internal.key.converter

Type: class
Default: org.apache.kafka.connect.json.JsonConverter
Importance: low
Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the keys in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. This setting controls the format used for internal bookkeeping data used by the framework, such as configs and offsets, so users can typically use any functioning Converter implementation. Deprecated; will be removed in an upcoming version.

internal.value.converter

Type: class
Default: org.apache.kafka.connect.json.JsonConverter
Importance: low
Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. This setting controls the format used for internal bookkeeping data used by the framework, such as configs and offsets, so users can typically use any functioning Converter implementation. Deprecated; will be removed in an upcoming version.

listeners

Type: list
Default: null
Importance: low
List of comma-separated URIs the REST API will listen on. The supported protocols are HTTP and HTTPS. Specify hostname as 0.0.0.0 to bind to all interfaces. Leave hostname empty to bind to default interface. Examples of legal listener lists: HTTP://myhost:8083,HTTPS://myhost:8084.

metadata.max.age.ms

Type: long
Default: 300000 (5 minutes)
Valid Values: [0,...]
Importance: low
The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

metric.reporters

Type: list
Default: ""
Importance: low
A list of classes to use as metrics reporters. Implementing the **org.apache.kafka.common.metrics.MetricsReporter** interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

metrics.num.samples

Type: int
Default: 2
Valid Values: [1,...]
Importance: low
The number of samples maintained to compute metrics.

metrics.recording.level

Type: string
Default: INFO
Valid Values: [INFO, DEBUG]
Importance: low
The highest recording level for metrics.

metrics.sample.window.ms

Type: long
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: low
The window of time a metrics sample is computed over.

offset.flush.interval.ms

Type: long
Default: 60000 (1 minute)
Importance: low
Interval at which to try committing offsets for tasks.

offset.flush.timeout.ms

Type: long
Default: 5000 (5 seconds)
Importance: low
Maximum number of milliseconds to wait for records to flush and partition offset data to be committed to offset storage before cancelling the process and restoring the offset data to be committed in a future attempt.

offset.storage.partitions

Type: int
Default: 25
Valid Values: Positive number, or -1 to use the broker's default
Importance: low
The number of partitions used when creating the offset storage topic.

offset.storage.replication.factor

Type: short
Default: 3
Valid Values: Positive number not larger than the number of brokers in the Kafka cluster, or -1 to use the broker's default
Importance: low
Replication factor used when creating the offset storage topic.

plugin.path

Type: list
Default: null
Importance: low
List of paths separated by commas (,) that contain plugins (connectors, converters, transformations). The list should consist of top level directories that include any combination of: a) directories immediately containing jars with plugins and their dependencies b) uber-jars with plugins and their dependencies c) directories immediately containing the package directory structure of classes of plugins and their dependencies Note: symlinks will be followed to discover dependencies or plugins. Examples:
plugin.path=/usr/local/share/java,/usr/local/share/kafka/plugins,/opt/connectors Do not use config provider variables in this property, since the raw path is used by the worker's scanner before config providers are initialized and used to replace variables.

reconnect.backoff.max.ms

Type: long
Default: 1000 (1 second)
Valid Values: [0,...]
Importance: low
The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

reconnect.backoff.ms

Type: long
Default: 50
Valid Values: [0,...]
Importance: low
The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

response.http.headers.config

Type: string
Default: ""
Valid Values: Comma-separated header rules, where each header rule is of the form '[action]

[header name]:[header value]' and optionally surrounded by double quotes if any part of a header rule contains a comma
Importance: low
Rules for REST API HTTP response headers.

rest.advertised.host.name

Type: string
Default: null
Importance: low
If this is set, this is the hostname that will be given out to other workers to connect to.

rest.advertised.listener

Type: string
Default: null
Importance: low
Sets the advertised listener (HTTP or HTTPS) which will be given to other workers to use.

rest.advertised.port

Type: int
Default: null
Importance: low
If this is set, this is the port that will be given out to other workers to connect to.

rest.extension.classes

Type: list
Default: ""
Importance: low
Comma-separated names of **ConnectRestExtension** classes, loaded and called in the order specified. Implementing the interface **ConnectRestExtension** allows you to inject into Connect's REST API user defined resources like filters. Typically used to add custom capability like logging, security, etc.

rest.host.name

Type: string
Default: null
Importance: low
Hostname for the REST API. If this is set, it will only bind to this interface.

rest.port

Type: int
Default: 8083
Importance: low
Port for the REST API to listen on.

retry.backoff.ms

Type: long
Default: 100
Valid Values: [0,...]
Importance: low
The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

sasl.kerberos.kinit.cmd

Type: string
Default: /usr/bin/kinit
Importance: low
Kerberos kinit command path.

sasl.kerberos.min.time.before.relogin

Type: long
Default: 60000
Importance: low
Login thread sleep time between refresh attempts.

sasl.kerberos.ticket.renew.jitter

Type: double
Default: 0.05
Importance: low
Percentage of random jitter added to the renewal time.

sasl.kerberos.ticket.renew.window.factor

Type: double
Default: 0.8
Importance: low
Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

sasl.login.refresh.buffer.seconds

Type: short
Default: 300
Valid Values: [0,...,3600]
Importance: low
The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.min.period.seconds

Type: short
Default: 60
Valid Values: [0,...,900]
Importance: low
The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.factor

Type: double
Default: 0.8
Valid Values: [0.5,...,1.0]

Importance: low
Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

sasl.login.refresh.window.jitter

Type: double
Default: 0.05
Valid Values: [0.0,...,0.25]
Importance: low
The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

scheduled.rebalance.max.delay.ms

Type: int
Default: 300000 (5 minutes)
Valid Values: [0,...,2147483647]
Importance: low
The maximum delay that is scheduled in order to wait for the return of one or more departed workers before rebalancing and reassigning their connectors and tasks to the group. During this period the connectors and tasks of the departed workers remain unassigned.

ssl.cipher.suites

Type: list
Default: null
Importance: low
A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

ssl.client.auth

Type: string
Default: none
Importance: low
Configures kafka broker to request client authentication. The following settings are common:

- **ssl.client.auth=required** If set to required client authentication is required.
- **ssl.client.auth=requested** This means client authentication is optional. unlike requested , if this option is set client can choose not to provide authentication information about itself
- **ssl.client.auth=none** This means client authentication is not needed.

ssl.endpoint.identification.algorithm

Type: string
Default: https
Importance: low
The endpoint identification algorithm to validate server hostname using server certificate.

ssl.engine.factory.class

Type: class
Default: null
Importance: low
The class of type org.apache.kafka.common.security.auth.SslEngineFactory to provide SSLEngine objects. Default value is org.apache.kafka.common.security.ssl.DefaultSslEngineFactory.

ssl.keymanager.algorithm

Type: string
Default: SunX509
Importance: low
The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

ssl.secure.random.implementation

Type: string
Default: null
Importance: low
The SecureRandom PRNG implementation to use for SSL cryptography operations.

ssl.trustmanager.algorithm

Type: string
Default: PKIX
Importance: low
The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

status.storage.partitions

Type: int
Default: 5
Valid Values: Positive number, or -1 to use the broker's default
Importance: low
The number of partitions used when creating the status storage topic.

status.storage.replication.factor

Type: short
Default: 3
Valid Values: Positive number not larger than the number of brokers in the Kafka cluster, or -1 to use the broker's default
Importance: low
Replication factor used when creating the status storage topic.

task.shutdown.graceful.timeout.ms

Type: long
Default: 5000 (5 seconds)
Importance: low
Amount of time to wait for tasks to shutdown gracefully. This is the total amount of time, not per task. All task have shutdown triggered, then they are waited on sequentially.

topic.creation.enable

Type: boolean
Default: true
Importance: low
Whether to allow automatic creation of topics used by source connectors, when source connectors are configured with **topic.creation.** properties. Each task will use an admin client to create its topics and will not depend on the Kafka brokers to create topics automatically.

topic.tracking.allow.reset

Type: boolean
Default: true
Importance: low
If set to true, it allows user requests to reset the set of active topics per connector.

topic.tracking.enable

Type: boolean
Default: true
Importance: low
Enable tracking the set of active topics per connector during runtime.

APPENDIX G. KAFKA STREAMS CONFIGURATION PARAMETERS

application.id

Type: string
Importance: high
An identifier for the stream processing application. Must be unique within the Kafka cluster. It is used as 1) the default client-id prefix, 2) the group-id for membership management, 3) the changelog topic prefix.

bootstrap.servers

Type: list
Importance: high
A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form **host1:port1,host2:port2,...**. Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

replication.factor

Type: int
Default: 1
Importance: high
The replication factor for change log topics and repartition topics created by the stream processing application.

state.dir

Type: string
Default: /tmp/kafka-streams
Importance: high
Directory location for state store. This path must be unique for each streams instance sharing the same underlying filesystem.

acceptable.recovery.lag

Type: long
Default: 10000
Valid Values: [0,...]
Importance: medium
The maximum acceptable lag (number of offsets to catch up) for a client to be considered caught-up for an active task.Should correspond to a recovery time of well under a minute for a given workload. Must be at least 0.

cache.max.bytes.buffering

Type: long
Default: 10485760
Valid Values: [0,...]
Importance: medium
Maximum number of memory bytes to be used for buffering across all threads.

client.id

Type: string
Default: ""
Importance: medium
An ID prefix string used for the client IDs of internal consumer, producer and restore-consumer, with pattern '<client.id>-StreamThread-<threadSequenceNumber>-<consumer|producer|restore-consumer>'.

default.deserialization.exception.handler

Type: class
Default: org.apache.kafka.streams.errors.LogAndFailExceptionHandler
Importance: medium
Exception handling class that implements the **org.apache.kafka.streams.errors.DeserializationExceptionHandler** interface.

default.key.serde

Type: class
Default: org.apache.kafka.common.serialization.Serdes$ByteArraySerde
Importance: medium
Default serializer / deserializer class for key that implements the **org.apache.kafka.common.serialization.Serde** interface. Note when windowed serde class is used, one needs to set the inner serde class that implements the **org.apache.kafka.common.serialization.Serde** interface via 'default.windowed.key.serde.inner' or 'default.windowed.value.serde.inner' as well.

default.production.exception.handler

Type: class
Default: org.apache.kafka.streams.errors.DefaultProductionExceptionHandler
Importance: medium
Exception handling class that implements the **org.apache.kafka.streams.errors.ProductionExceptionHandler** interface.

default.timestamp.extractor

Type: class
Default: org.apache.kafka.streams.processor.FailOnInvalidTimestamp
Importance: medium
Default timestamp extractor class that implements the **org.apache.kafka.streams.processor.TimestampExtractor** interface.

default.value.serde

Type: class
Default: org.apache.kafka.common.serialization.Serdes$ByteArraySerde
Importance: medium
Default serializer / deserializer class for value that implements the **org.apache.kafka.common.serialization.Serde** interface. Note when windowed serde class is used, one needs to set the inner serde class that implements the **org.apache.kafka.common.serialization.Serde** interface via 'default.windowed.key.serde.inner' or 'default.windowed.value.serde.inner' as well.

max.task.idle.ms

Type: long
Default: 0
Importance: medium

Maximum amount of time a stream task will stay idle when not all of its partition buffers contain records, to avoid potential out-of-order record processing across multiple input streams.

max.warmup.replicas

Type: int
Default: 2
Valid Values: [1,...]
Importance: medium
The maximum number of warmup replicas (extra standbys beyond the configured num.standbys) that can be assigned at once for the purpose of keeping the task available on one instance while it is warming up on another instance it has been reassigned to. Used to throttle how much extra broker traffic and cluster state can be used for high availability. Must be at least 1.

num.standby.replicas

Type: int
Default: 0
Importance: medium
The number of standby replicas for each task.

num.stream.threads

Type: int
Default: 1
Importance: medium
The number of threads to execute stream processing.

processing.guarantee

Type: string
Default: at_least_once
Valid Values: [at_least_once, exactly_once, exactly_once_beta]
Importance: medium
The processing guarantee that should be used. Possible values are **at_least_once** (default), **exactly_once** (requires brokers version 0.11.0 or higher), and **exactly_once_beta** (requires brokers version 2.5 or higher). Note that exactly-once processing requires a cluster of at least three brokers by default what is the recommended setting for production; for development you can change this, by adjusting broker setting **transaction.state.log.replication.factor** and **transaction.state.log.min.isr**.

security.protocol

Type: string
Default: PLAINTEXT
Importance: medium
Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

topology.optimization

Type: string
Default: none
Valid Values: [none, all]
Importance: medium
A configuration telling Kafka Streams if it should optimize the topology, disabled by default.

application.server

Type: string
Default: ""
Importance: low
A host:port pair pointing to a user-defined endpoint that can be used for state store discovery and interactive queries on this KafkaStreams instance.

buffered.records.per.partition

Type: int
Default: 1000
Importance: low
Maximum number of records to buffer per partition.

built.in.metrics.version

Type: string
Default: latest
Valid Values: [0.10.0-2.4, latest]
Importance: low
Version of the built-in metrics to use.

commit.interval.ms

Type: long
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: low
The frequency with which to save the position of the processor. (Note, if **processing.guarantee** is set to **exactly_once**, the default value is **100**, otherwise the default value is **30000**.

connections.max.idle.ms

Type: long
Default: 540000 (9 minutes)
Importance: low
Close idle connections after the number of milliseconds specified by this config.

metadata.max.age.ms

Type: long
Default: 300000 (5 minutes)
Valid Values: [0,...]
Importance: low
The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

metric.reporters

Type: list
Default: ""
Importance: low
A list of classes to use as metrics reporters. Implementing the **org.apache.kafka.common.metrics.MetricsReporter** interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

metrics.num.samples

Type: int

Default: 2
Valid Values: [1,...]
Importance: low
The number of samples maintained to compute metrics.

metrics.recording.level

Type: string
Default: INFO
Valid Values: [INFO, DEBUG]
Importance: low
The highest recording level for metrics.

metrics.sample.window.ms

Type: long
Default: 30000 (30 seconds)
Valid Values: [0,...]
Importance: low
The window of time a metrics sample is computed over.

partition.grouper

Type: class
Default: org.apache.kafka.streams.processor.DefaultPartitionGrouper
Importance: low
Partition grouper class that implements the **org.apache.kafka.streams.processor.PartitionGrouper** interface. WARNING: This config is deprecated and will be removed in 3.0.0 release.

poll.ms

Type: long
Default: 100
Importance: low
The amount of time in milliseconds to block waiting for input.

probing.rebalance.interval.ms

Type: long
Default: 600000 (10 minutes)
Valid Values: [60000,...]
Importance: low
The maximum time to wait before triggering a rebalance to probe for warmup replicas that have finished warming up and are ready to become active. Probing rebalances will continue to be triggered until the assignment is balanced. Must be at least 1 minute.

receive.buffer.bytes

Type: int
Default: 32768 (32 kibibytes)
Valid Values: [-1,...]
Importance: low
The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

reconnect.backoff.max.ms

Type: long
Default: 1000 (1 second)
Valid Values: [0,...]
Importance: low
The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

reconnect.backoff.ms

Type: long
Default: 50
Valid Values: [0,...]
Importance: low
The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

request.timeout.ms

Type: int
Default: 40000 (40 seconds)
Valid Values: [0,...]
Importance: low
The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

retries

Type: int
Default: 0
Valid Values: [0,...,2147483647]
Importance: low
Setting a value greater than zero will cause the client to resend any request that fails with a potentially transient error.

retry.backoff.ms

Type: long
Default: 100
Valid Values: [0,...]
Importance: low
The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

rocksdb.config.setter

Type: class
Default: null
Importance: low
A Rocks DB config setter class or class name that implements the **org.apache.kafka.streams.state.RocksDBConfigSetter** interface.

send.buffer.bytes

Type: int

Default: 131072 (128 kibibytes)
Valid Values: [-1,...]
Importance: low
The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

state.cleanup.delay.ms

Type: long
Default: 600000 (10 minutes)
Importance: low
The amount of time in milliseconds to wait before deleting state when a partition has migrated. Only state directories that have not been modified for at least **state.cleanup.delay.ms** will be removed.

upgrade.from

Type: string
Default: null
Valid Values: [null, 0.10.0, 0.10.1, 0.10.2, 0.11.0, 1.0, 1.1, 2.0, 2.1, 2.2, 2.3]
Importance: low
Allows upgrading in a backward compatible way. This is needed when upgrading from [0.10.0, 1.1] to 2.0+, or when upgrading from [2.0, 2.3] to 2.4+. When upgrading from 2.4 to a newer version it is not required to specify this config. Default is **null**. Accepted values are "0.10.0", "0.10.1", "0.10.2", "0.11.0", "1.0", "1.1", "2.0", "2.1", "2.2", "2.3" (for upgrading from the corresponding old version).

windowstore.changelog.additional.retention.ms

Type: long
Default: 86400000 (1 day)
Importance: low
Added to a windows maintainMs to ensure data is not deleted from the log prematurely. Allows for clock drift. Default is 1 day.

APPENDIX H. USING YOUR SUBSCRIPTION

AMQ Streams is provided through a software subscription. To manage your subscriptions, access your account at the Red Hat Customer Portal.

Accessing Your Account

1. Go to access.redhat.com.
2. If you do not already have an account, create one.
3. Log in to your account.

Activating a Subscription

1. Go to access.redhat.com.
2. Navigate to **My Subscriptions**.
3. Navigate to **Activate a subscription** and enter your 16-digit activation number.

Downloading Zip and Tar Files

To access zip or tar files, use the customer portal to find the relevant files for download. If you are using RPM packages, this step is not required.

1. Open a browser and log in to the Red Hat Customer Portal **Product Downloads** page at access.redhat.com/downloads.
2. Locate the **Red Hat AMQ Streams** entries in the **JBOSS INTEGRATION AND AUTOMATION** category.
3. Select the desired AMQ Streams product. The **Software Downloads** page opens.
4. Click the **Download** link for your component.

Registering Your System for Packages

To install RPM packages on Red Hat Enterprise Linux, your system must be registered. If you are using zip or tar files, this step is not required.

1. Go to access.redhat.com.
2. Navigate to **Registration Assistant**.
3. Select your OS version and continue to the next page.
4. Use the listed command in your system terminal to complete the registration.

To learn more see How to Register and Subscribe a System to the Red Hat Customer Portal .

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